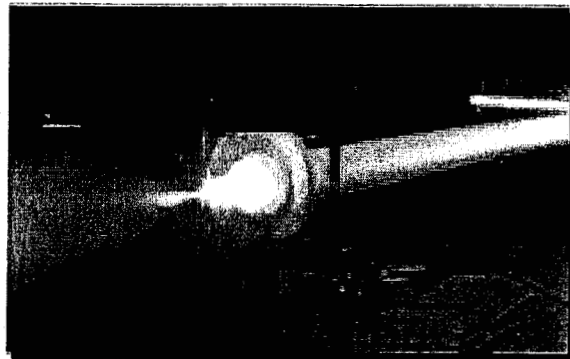


Research Center for Optical Physics



Education and Technology for the 21st Century

FINAL REPORT 1992 – 2003

Doyle A. Temple
Director

DEPARTMENT OF PHYSICS
HAMPTON UNIVERSITY



Funded by the Office of Equal Opportunity Programs
Minority University Research and Education Division
MURED
NATIONAL AERONAUTICS AND SPACE
ADMINISTRATION
Grant #NCC 1-251

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RCOP

Research Center for Optical Physics **FINAL REPORT 1992 - 2003**

1. PROGRAM OVERVIEW

During the past eleven years since its inception, RCOP has excelled in its two primary goals: 1) training of the scientists and engineers needed for the twenty-first century with special emphasis on underrepresented citizens and 2) research and technological development in areas of relevance to NASA.

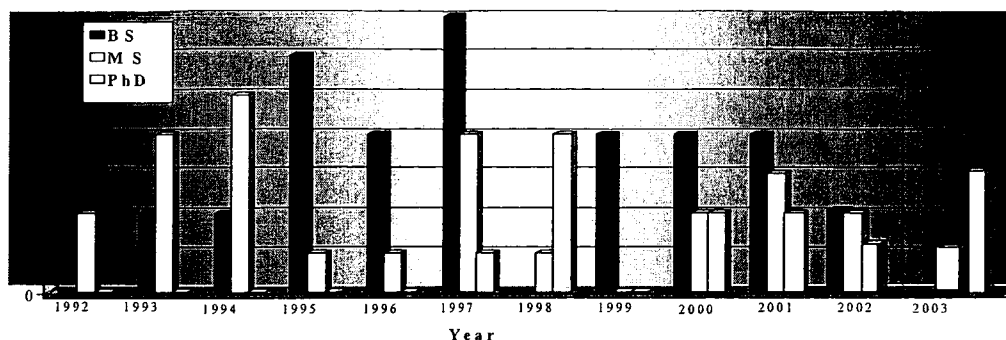
In the category of research training, as of May 2003, RCOP produced 36 Bachelors degrees, 25 Masters degrees, and 13 Doctoral degrees. Of these, all 36 Bachelors degrees, 16 of the Masters degrees and 9 of the Doctoral degrees were awarded to African Americans. Four of the Doctoral graduates and one of the Masters graduates are working at NASA Field Centers. RCOP has also provided research experiences to 130 undergraduate students and 22 high school students through a number of outreach programs held during the summer and the academic year. RCOP has also been crucial to the development of the Ph.D. program in physics at Hampton University by providing high quality research training and technical electives required for a Doctoral degree in physics.

RCOP has also excelled in research and technological development. Since 1992, RCOP researchers have leveraged over \$8 M in additional research funding, published 152 papers in refereed journals and proceedings, and given 125 presentations at refereed international conferences in the United States and eight other countries. RCOP also developed numerous collaborations with other research centers, universities and industries. In recognition of this outstanding work, RCOP is the first research center in the United States invited to join the Joint Open Laboratory for Laser Crystals and Precise Laser Systems headed by Dr. Alexander Kaminiskii of the Russian Academy of Sciences.

Program Highlights (1992-2003)

- Awarded 13 Ph.D.'s in Physics, 9 to African Americans (5 women and 4 men)
- Awarded 25 Masters degrees in Physics, 16 to African Americans
- Awarded 36 Bachelors degrees in Science and Engineering, all to African Americans
- 5 former students are working at NASA Field Centers (4 Ph.D. and 1 Masters)
- Leveraged more than \$8M in additional grant funding
- Published 152 articles in international refereed journals and refereed proceedings
- Presented 125 scientific talks at refereed international conferences
- Students have given technical presentations at conferences in 8 countries
- Conducted numerous summer undergraduate intern programs with a total of 94 African American student participants from around the country
- Mentored 22 high school students through the NASA SHARPE program
- Held 12 Saturday science workshops for 79 elementary school students
- Held a student retention workshop in collaboration with the NSF AMP Program
- Held 3 high school teacher summer science workshops with more than 130 participants
- Students and faculty participated as judges in 42 HS science fairs
- Held elementary school model rocket clubs with more that 500 participants
- Student Awards
 - 2 National Research Council (NRC) Postdoctoral Fellowships
 - 2 National Science Foundation (NSF) Postdoctoral Fellowships
 - 3 Office of Naval Research (ONR) Graduate Fellowships
 - 1 Optical Society of America (OSA) Congressional Postdoctoral Fellowship
 - 8 Virginia Space Grant Graduate Fellowships
 - Undergraduate Mr. Boadu was elected President of the International Association of Physics Students

2. DEGREES AWARDED



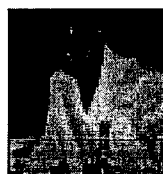
Histogram of degrees awarded to Hampton URC students between 1992 and 2003.

2.1 Ph.D. Recipients



Photo not available

Kang Seo 1997
Research Associate, Norfolk
State University



Florence Etop 1998
Full time homemaker

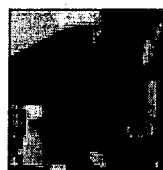


Hyung Rip Lee 1998
NASA Langley Research
Center

Apriel Hodari 1998
OSA Congressional
Fellowship.



Melvin Spurlock 1998
(deceased 1998)
Postdoc at Norfolk State
University.



Kenneth Samuel 2000
Research Scientist at the
Naval Research Laboratory



Charles Terrell 2000
National Research Council
(NRC) Postdoctoral Fellow at
the NASA Jet Propulsion
Laboratory.



Erica Thompson 2001
Postdoctoral Fellow at the
California Institute of
Technology.



Christophe McCray
2001
Project leader at DRS
Technology in Florida.



Sang Lee 2002
Postdoctoral Fellow at the
NASA Goddard Spaceflight
Center



Renee Payne-Baggott
2003
Scientist, NASA Langley
Research Center



Althea Bluiett 2003
NRC Postdoc at the Naval
Research Laboratory



Ei Ei Nyein 2003
Postdoctoral Fellow,
Hampton University

2.2 Bachelors Degrees Awarded

Last Name Last, First MI	Gender/ Ethnicity	Major	Citizenship	Year	Post Graduation
Coleman, Craig	Male\African Am.	Physics	US	1993	Graduate school at George Mason Univ.
Johnson, Alicia R.	Female\African Am.	Physics	US	1993	Graduate School in Nuclear Physics at HU
Moore, Michael	Male\African Am	Comp. Sci.	US	1994	
Russell, Edgar	Male\African Am	Physics	US	1994	
Robinson, Travis	Male\African Am	Comp. Sci.	US	1994	
Anderson, Andrea R.	Female\African Am.	Elect. Engr	US	1995	
Dumas-, Keisha	Female\African Am.	Physics	US	1995	Graduate School at William and Mary
Bonaparte, Justin	Male\African Am	Physics	US	1995	
Hairston, Brian	Male\African Am	Physics	US	1995	Secondary school teacher Chesapeake City Schools
Lee, Krista	Female\African Am.	Physics	US	1995	Commissioned in the Marine Corps
Lofton, Lakela	Female\African Am.	Elect. Engr	US	1995	
Atkins, Adontis	Male\African Am.	Elect. Engr	US	1996	Commissioned in the NAVY
Bell, Raymond C.	Male\African Am.	Airway Science	US	1996	Commissioned in the Air Force
Goss, Tyhesha N.	Female\African Am.	Physics	US	1996	Optometry School
Lane, Ryan	Male\African Am.	Physics	US	1996	Commissioned in the NAVY
Bath, Desirée	Female\African Am.	Physics	US	1997	Graduate School Georgia Tech
Clingman, Chekesha	Female\African Am.	Physics	US	1997	Graduate School Johns Hopkins
Fields, Aisha	Female\African Am.	Physics	US	1997	Graduate School Alabama A&M
Hudson, Tosha	Female\African Am.	Physics	US	1997	Graduate school Cleveland State Univ.
Hurts, Donald	Male\African Am.	Elect. Engr	US	1997	Working in the Music Industry
Lucas, Michael	Male\African Am	Physics	US	1997	Department of Defense Contractor
Pendergrass, LeRuth	Female\African Am.	Elect. Engr	US	1997	Graduate School at Georgia Tech
Elivert, Roosevelt	Male\African Am	Elect. Engr	US	1999	Nortel Telecom
McNeil, Jason	Male\African Am	Physics	US	1999	Graduate School at HU
Brown, Terrence	Male\African Am	Physics	US	1999	Lockheed Martin
Turner, Eric	Male\African Am	Elect. Engr	US	1999	Lockheed Martin
Johnson, Katron	Male\African Am	Elect. Engr	US	2000	Graduate School ODU
Poku, Maame	Female\African Am	Chem. Engr.	US	2000	Graduate School Carnegie Mellon
Thomas, Brandi	Female\African Am	Physics	US	2000	Torch Technologies
Toppin, Crystal	Female\African Am	Physics	US	2000	Graduate School Univ. of Wisconsin
Jackson, Kim	Female\African Am	Physics	US	2001	Graduate School Univ. of Michigan
McNeil, Derrick	Male\African Am	Physics	US	2001	Graduate School Univ. of Michigan
Mims, Kenneth	Male\African Am	Physics	US	2001	Applying for graduate school
Ofori-Bodu, George	Male\African Am	Physics	US	2001	Medical school Univ. of Virginia
Cyril Wiggins	Male\African Am	Physics	US	2002	Masters program at Hampton
Rickey Torrence	Male\African Am	Physics	US	2002	Lawrence Livermore Lab

2.3 Masters Degrees Awarded

Name Last, First MI	Gender/ Ethnicity	Citizen ship	Major	Year	Post Graduation
Cho, Yong Su	Male\Korean	Korean	Physics	1992	
Choi, Jaeho	Male\Korean	Korean	Physics	1992	
Allen-Wells, Donica	Female\African Am.	US	Physics	1993	
Copeland, Randolph	Male\African Am.	US	Physics	1993	
Han, Goowan	Male\Korean	Korean	Physics	1993	Ph.D. Program Boston College
Veal, Trina	Female\African Am.	US	Physics	1993	Continued in the Ph.D. Program at HU
Lee, Sangwoo	Male\Korean	Korean	Physics	1994	Continued in the Ph.D. Program at HU
Lee, Hyung R.	Male\Korean	Korean	Physics	1994	Continued in the Ph.D. Program at HU
Hodari, Apriel K.	Female\African Am.	US	Physics	1994	Continued in the Ph.D. Program at HU
Nguyen, Dung X.	Male\Vietnamese	US	Physics	1994	
Terrell, Charles A.	Male\African Am.	US	Physics	1994	Continued in the Ph.D. Program at HU
Johnson, Alicia	Female\African Am.	US	Physics	1995	Continued in the Ph.D. Program at HU
McCray, Christophe	Male\African Am.	US	Physics	1996	Continuing in the Ph.D. Program at HU
Brass, Eric	Male\African Am.	US	Physics	1997	Continued in the Ph.D. Program at HU
Spraggins, Darrell	Male\African Am	US	Physics	1997	Thomas Jefferson National Laboratory
Khet, Marcie	Female Burmese	US	Physics	1997	Continued in the Ph.D. program at HU
White, Renita	Female\African Am	US	Physics	1997	Continued in the Ph.D. Program at HU
Thaik, Myo	Female\Asian	Burma	Physics	1998	Ph.D. program at Stony Brook, NY
Quiett, Carramah	Female\African Am	US	Physics	2000	Continued in the Ph.D. Program at HU
David, Rouald	Male	Ghana	Physics	2001	Physics teacher, Pebos High School
Payne-Baggott, Renee	Female\African Am	US	Physics	2001	Continued in the Ph.D. Program at HU
Turner, Matthew	Male\African Am	US	Physics	2001	NASA Langley
Jason McNeil	Male\African Am	Physics	US	2002	Continued in the MS. Program at HU
Mike Fields	Male\African Am	US	Physics	2002	Army Research Laboratory
Santiel Creekmore	Male\African Am	US	Physics	2003	HU Ph.D. Program

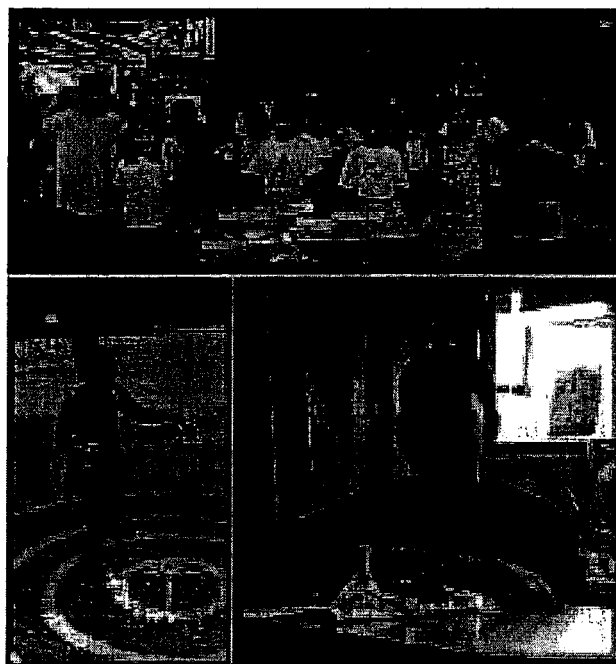
3. OUTREACH PROGRAMS

The outreach program for RCOP consisted of three main components: precollege, undergraduate, and teacher enhancement. The overall goal of RCOP's outreach program was to provide students with world-class education and training in optics and related disciplines, with a special emphasis on underrepresented students. The faculty of RCOP participated in every aspect of these outreach efforts.

3.1 Pre-College Programs

Adopt-A-Class Program

The "Adopt-a-Class" project was an outreach effort to provide hands-on experiences in science that were fun and educational, and to demonstrate to young students that science is exciting and interesting and that a career in science is possible for them. For instance, the third grade class at R. O. Nelson elementary school (shown at right) enjoyed building, painting and blasting off their own model rockets. The project was a great success and was replicated at several other schools. The students were excited to interact with a scientist who could answer their innocent and far out scientific questions with logical and understandable answers, while they worked on the construction of their rockets.

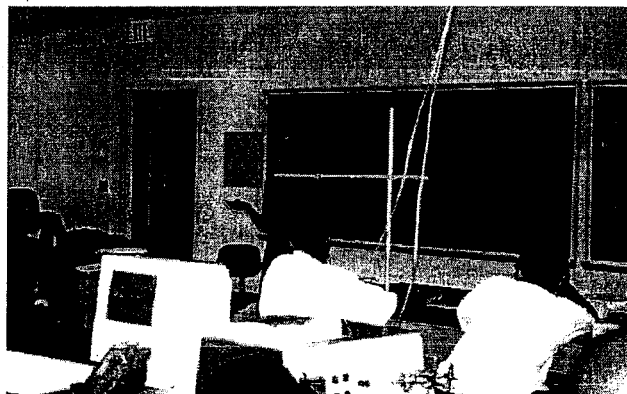


NASA SHARP PLUS

SHARP Plus is a program funded by NASA in order to provide outstanding underrepresented students from around the country the opportunity to study in a rich research environment. This program was a collaboration between Hampton University and NASA-Langley through the Quality Education for Minorities (QEM) program. RCOP faculty mentored one to three SHARP Plus students each year.

African American Male Math and Science Academy

Graduate students Ms. Valetta Davis, Ms. Apriel Hodari and Mr. Darrell Spraggins conducted introductory physics laboratory exercises with middle school African American male students.



3.2 Teacher Enhancement

The Summer Institute for Teacher Enhancement (SITE) was a program funded by the U.S. Department of Energy (DOE). This program was hosted by the Thomas Jefferson National Accelerator Facility formally CEBAF. SITE provided hands-on research experiences for 130 participating middle and high school teachers. The teachers learned how to use lasers as a teaching tool in their sciences courses, toured the Graduate Physics Research Center and received laser pointers as an additional benefit.



3.3 Recruitment and Retention Workshop

The Department of Physics hosted the Washington Baltimore Hampton Roads - Alliance for Minority Participation (WBHR-AMP) Workshop on Successful Outreach Programs: recruitment and Retention. This workshop was held in McGrew Towers on the campus of Hampton University on November 17, 1995. This workshop focused on successful outreach programs for recruitment and retention of underrepresented science students. The objectives of this workshop were to explore opportunities in establishing linkages between four year universities and community colleges and to address key issues concerning the matriculation of students. The agenda is listed on the next page. Dr. Warren Buck, Professor of Physics moderated this workshop. We had informative talks by people with success on the theme of recruitment and retention. There were also working groups that focused on specific topics. The overall workshop was very successful.

3.4 Seminar Series

RCOP held a colloquium series each year. In this colloquium, distinguished scientists



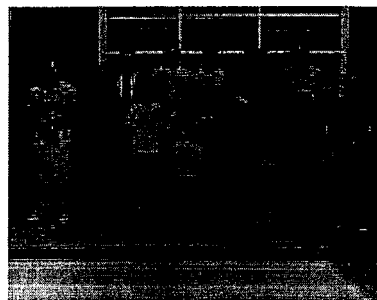
presented seminars on their research. Just a few of the 73 presenters included: Noble Laureate and Harvard University Professor Dr. Nicolaas Bloembergen (shown at left with Ph.D. student Christophe McCray), Dr. M.S. Dresselhaus MIT Institute Professor of Physics and past President of the American Physical Society, and Dr. Gerard Mourou, Professor and Director, Center for Ultrafast Optical Science, University of Michigan.

3.5 Undergraduate Summer Programs

Every summer since 1993, RCOP has sponsored, either through URC funds or other grants, at least one summer intern program for undergraduates. In these programs, 94 undergraduates from around the country spent six to eight weeks on campus working directly with an RCOP faculty member on a specific problem. Students also received lectures on current topics in optical physics as well as field trips to other research and educational facilities. Seven African American students were recruited into the RCOP graduate program from the summer programs.

Post-Baccalaureate Summer Research Program 1993-1994

The Post-Baccalaureate Summer Research Program (PSRP) was an eight-week summer program held in 1993 and 1994 for undergraduates that have completed their junior year of college. The goals of this program were to provide underrepresented undergraduates with experiences in state-of-the-art computer technology, research methods, and improvement of mathematical skills and enhancement of technical writing skills.



Alliance for Minority Participation - Summer Physics Institute 1995 (AMP-SPI)



The Summer Physics Institute (SPI) was held from June 19 through July 28, 1995 for junior and senior physics majors. The academic training consisted of a three-credit hour course on optical and mathematical physics. The students were also paired with research scientists from RCOP and NASA/LaRC.

Undergraduate Institute in Physics (UnIPhy) 1996 - 2003

Principal Investigators

Dr. Claudia Rankins and Dr. Doyle Temple

The Undergraduate Institute in Physics (UnIPhy), funded by the NSF REU program, has been held every summer since 1996. This program targeted undergraduate physics students, who have completed at least their second year of course work in physics.



Advanced Undergraduate Research using Optical Radiation in the Atmosphere (AURORA) 1998 - 2000

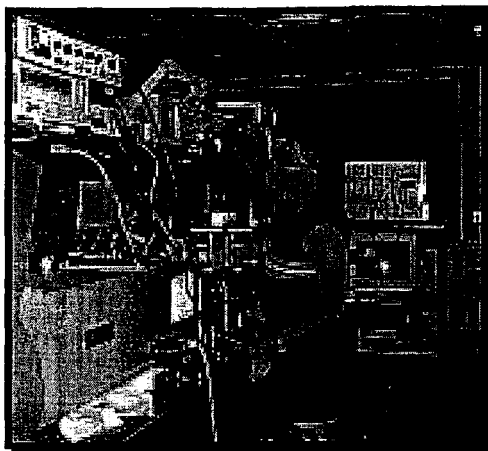
Dr. Doyle Temple, Principal Investigator

AURORA was a six-week, undergraduate summer program established to provide undergraduates with quality research experiences in laser and atmospheric sciences and to encourage them to pursue graduate studies and careers in science. The participants conducted cutting edge research under the guidance of world-class research scientists at Hampton University.

4. RESEARCH OUTCOMES

4.1 National and International Recognition

- RCOP is the first research center in the U.S. to be invited to join an international network of research centers in The Joint Open Laboratory for Laser Crystals and Precise Laser Systems, Directed by Dr. Alexander Kaminiskii, of the Russian Academy of Sciences.
- The HU Ozone Lidar instrument was highlighted in the optics trade magazine *Photonics Spectra*
- The first discovery of Er^{3+} ions in nanostructures of porous silicon by RCOP faculty was the feature article in *Laser Focus World*, September 1996.
- RCOP faculty have received the prestigious NSF Career Award
- RCOP Students have presented their work at conferences in eight countries



4.2 Equipment and Facilities Enhancements

Facilities

Currently, RCOP occupies 16 high quality laboratories with over 6,500 sq.ft. of laboratory space. These laboratories include:

- One Bridgman crystal growth laboratory
- One Czochralski crystal growth laboratory
- One materials preparation laboratory
- Two Lidar laboratories
- Eleven state-of-the-art laser spectroscopy laboratories

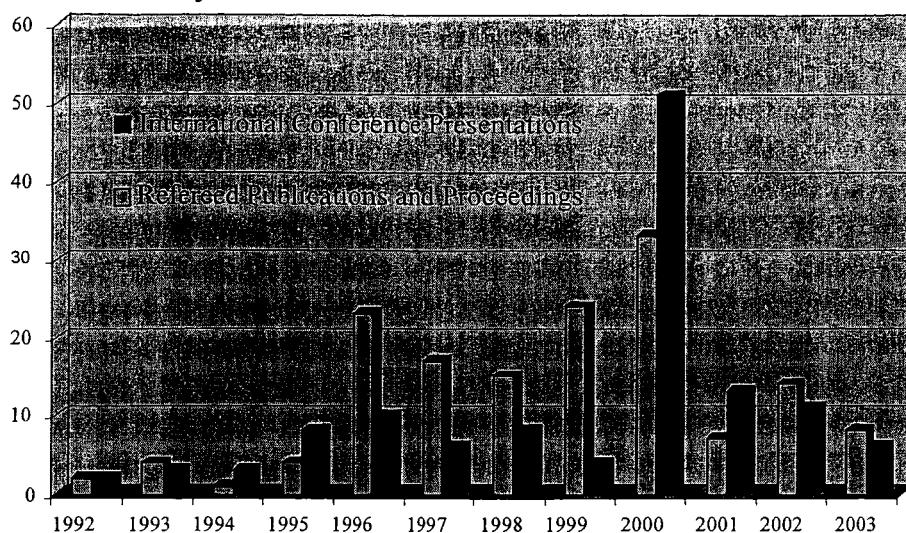


Equipment

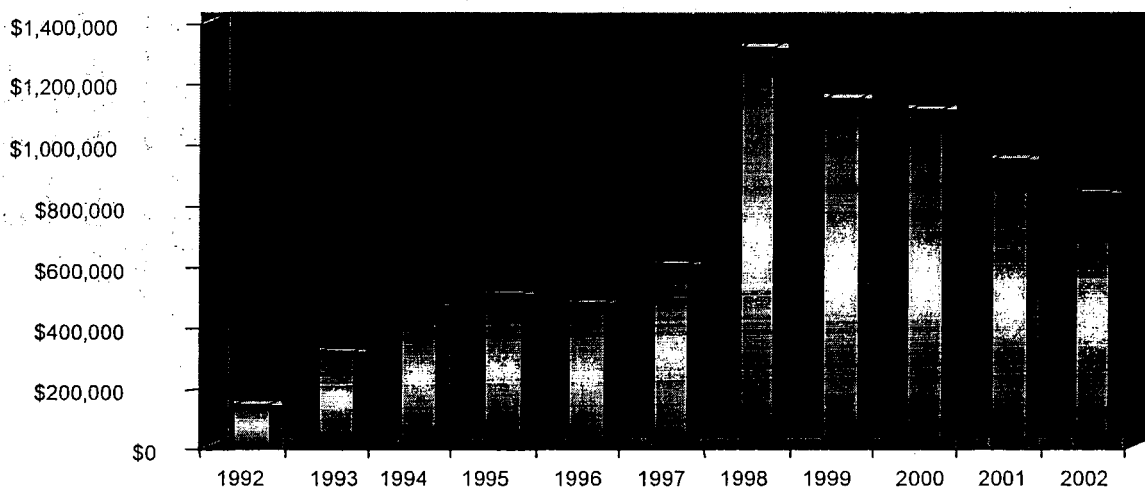
RCOP currently has over \$5 M of state-of-the-art research equipment including:

- Four Bridgman crystal growth furnaces
- Two Czochralski crystal growth furnaces
- Seven argon ion lasers
- Two ultrafast pulsed laser systems
- Four Yag lasers
- Three lidar instruments
- One excimer laser
- Twelve precision optics tables
- A high vacuum solar propulsion simulator

4.3 Research Productivity



Histogram of RCOP refereed publications, proceedings and conference talks. (see Appendix B)



Histogram of RCOP external grant funding. (see Appendix C)

4.4 Governmental, Industrial and Academic Partnerships

Agilent Technologies
Brimrose Corporation
California State University at Sacramento
Coherent, Inc.
Corning, Inc.
European Army Research Office
ITT Industries
Laser Energetics, Inc.
Howard University

MIT
NASA Glenn
NASA Langley
NASA Marshall
Northrop-Grumman Aerospace
Russian Academy of Sciences
Stanford University
University of Cincinnati
University of Illinois

APPENDIX A: Profiles of Faculty Participants

Dr. Thomas Chyba, Associate Professor of Physics

1995 - 2001

Dr. Thomas Chyba received his Ph.D. in 1990 from the University of Rochester. From 1990 until 1993 he was a National Research Council Research Associate with Dr. Edward Browell's Lidar Applications Group in the Chemistry and Dynamics Branch, Atmospheric Sciences Division, NASA Langley Research Center. From 1993 until 1995, he was a Research Scientist at the College of William and Mary associated with the same group. In 1995, Dr. Chyba joined the Department of Physics at Hampton University. He is now an Associate Professor and serves as Associate Director of the Research Center for Optical Physics (RCOP) and Co-Director of the Center for Lidar and Atmospheric Science Students (CLASS). His laboratory in RCOP specializes in laser development and lidar applications. Dr. Chyba has authored/co-authored over 30 technical articles and has presented numerous papers at conferences and technical meetings. Dr. Chyba is a member of the Optical Society of America, the American Association of Physics Teachers, the American Physical Society, and the International Society for Optical Engineering.

Usamah Farrukh, Professor of Electrical Engineering

1992 - 1994

Dr. Farrukh received his Ph.D. in Electrical Engineering from the University of Southern California. His areas of research include laser system modeling; optical systems and detectors; laser propagation in scattering media; atmospheric optical properties and analysis and software development for optical and ballistic systems. He has more than 30 publications in refereed journals.

Dr. Kwang Han, Professor of Physics

1992 - 1993

Dr. Han's research interests are in plasma and laser physics. He has more than 27 years of service at Hampton University. He received his Ph.D. degree in physics from the College of William and Mary.

Dr. Uwe Hömmerich, Associate Professor of Physics

1995 - 2003

Dr. Uwe Hömmerich received his Ph. D. in physics from the University of Hamburg in 1994. His dissertation research was on the optical spectroscopy of new transition metal laser materials. He spent a postdoctoral year at the University of Wisconsin-Madison before he joined the Department of Physics at Hampton University in 1995. Dr. Hömmerich has authored/co-authored over 50 technical articles in the area of optical spectroscopy of rare earth and transition metal based solid-state laser materials.

In Hwang, Associate Professor of Physics

1992 - 1994

Dr. Hwang received his Ph.D. degree in physics from the Korean Advanced Institute of Science. His area of research includes the use of diode lasers in the development of a solid state lasers.

Dr. Nelson Jalufka, Associate Professor of Physics

1992 - 1994

Dr. Jalufka received his Ph.D. degree in physics from the University of Colorado at Boulder. He joined the physics department at Hampton University in 1990. Prior to that he was a senior research scientist at NASA LARC. His area of research is atomic and molecular spectroscopy.

Donald Lyons, Professor of Physics

1993 - 2003

Dr. Lyons received his B.S. degree in physics from Grambling State University and his M.S. and Ph.D. degrees in physics from Stanford University. Before coming to Hampton he was a Senior Research Scientist at Grumman Aerospace Corporation. He joined the Hampton University faculty in August, 1993 as an associate professor of physics. His area of research is the application of intrinsic and extrinsic fiber optic Fabry-Perot sensors to Smart materials and structures.

Arlene Maclin, Research Professor of Physics

1992 - 1994

Dr. Maclin received her B.S. degree in physics from north Carolina A&T State University, M.S. degree from the University of Virginia and her Ph.D. degree in theoretical solid state physics from Howard University.

Dr. Jae Tae Seo, Assistant Professor of Physics

1999 - 2003

Dr. JaeTae Seo received his Ph.D. in laser and plasma physics from Hampton University in 1997. His dissertation was on the laser development based on transition metal ion-doped solid state and optical nonlinear materials, optical spectroscopy of dense plasma, and plasma pulse power development. He spent his postdoctoral years in the research center for optical physics before he joined as a faculty member in the Physics Department at Hampton University in 1999. Dr. Seo has authored or co-authored over 70 journal or technical articles in the areas of optical spectroscopy of optical materials, laser development, and plasma pulse power development. His current research interest areas are optical spectroscopy of rare-earth ion-doped solids, laser development based on rare-earth ion-doped solids and optical nonlinear materials.

Garfield Simms, Assistant Professor of Applied Mathematics

1992 - 1993

Dr. Simms received his B.S. Degree in physics from Delaware State University and his M.S. and Ph.D. degrees in electrical engineering from the University of Delaware.. Dr. Simms has two patents in the area of fiber optic transmission lines:

Alphonso Smith, Associate Professor of Electrical Engineering

1992 - 1994

Dr. Smith is a faculty associate of Electrical Engineering. His research interest are in ultrasonics and the use of fiber optics to study smart materials. He joined the Hampton University community in 1991. He received his Ph.D. degree in electrical engineering from Virginia Polytechnic and State University.

Carl Spight, Adjunct Professor

1992 - 1993

Dr. Spight, Director of Scientific Research, Jackson and Tull and Graham has had extensive university and high technology experience, both as a manager and as a scientist-technologist. In industry he has directed a division with more than 30 software development efforts under government (DOD, FAA) contracts.

Bagher Tabibi, Associate Professor of Physics

1992 - 2003

Dr. Tabibi received his Ph.D. from Moscow State University. His area of research involves atomic and molecular spectroscopy, laser optics, and non-intrusive optical flow and plasma diagnostics. He has over 25 years of experiences in experimental research in the mentioned

areas. He has 9 years research experience in the field solar-pumped lasers at NASA Lagley Research Center. He has developed optical diagnostic techniques – electron beam fluorescence, focusing Schlieren, and laser-induced fluorescence for the super/hypersonic flow diagnostics. These non-intrusive optical spectroscopic techniques offer the possibility of detecting molecules and atoms, measuring species concentrations, determining energy level population distribution and probing energy transfer processes (including relaxation) in molecules and atoms. He joined the Hampton University faculty in 1983 and is currently a Professor of Physics.

Dr. Doyle Temple, Professor of Physics

1994 - 2003

Dr. Temple received his B.S. Degree from Southern University and his Ph.D. from the Massachusetts Institute of Technology. He was an Assistant Professor of Physics at Louisiana State University from 1988 to 1994. Also during that time he was founder and president of Applied Physics, Inc. a high tech company that specialized in single crystal growth of optical materials with funding from Louisiana venture capitalists and the DOD SBIR program. In June of 1994 he joined Hampton University as Associate Professor of Physics and Chair. His research interests are in crystal growth and spectroscopy of new optical materials primarily for use in holographic data storage devices. He is a member of the American Association of University Professors, the American Association of Physics Teachers, the Institute of Electrical and Electronics Engineers, the International Society for Optical Engineering, the Optical Society of America and the Sigma Pi Sigma Physics Honor Society.

Demetrius Venable, Vice President for Research

1992 - 1995

Dr. Venable was the director and principal investigator of RCOP between 1992 and 1994. He has held prior positions at the university serving as professor and chairman of physics, Dean of the graduate school and Vice President for Research. He has more than 14 years of service to Hampton University and holds a Ph.D. degree in physics from American University.

APPENDIX B: Refereed Publications, Proceedings and Book Chapters

Many conference talks are accompanied by refereed conference proceedings. Therefore, refereed conference proceedings publications will also be listed under conference talks.

Book Chapter:

J.M. Zavada, U. Hömmerich, and A. J. Steckl, "Light Emission from Rare Earth doped GaN", chapter in book entitled: *III-V Nitride Semiconductors: Optical Properties*, Volume 13, edited by M. O. Manasreh and H. X. Jiang, Taylor & Francis Books, 2002.

January – May 2003 Statistics

Refereed Publications and Conference Proceedings

1. J.M. Zavada, R.G. Wilson, U. Hommerich, M. Thaik, J.T. Seo, C.J. Ellis, J.Y. Lin, and H.X. Jiang, "Compositional Changes in Erbium-Implanted GaN Films due to Annealing," *J. of Electronic Materials*, 32 (5), 382 (2003).
2. J.T. Seo, Q. Yang, S. Creekmore, D. Temple, M. Namkung, S.S. Jung, and J.H. Kim, "Evaluation of Nonlinear Optical Properties of Cadmium Chalcogenide Nanomaterials," *Physica E*, 17, 101 (2003).
3. Q. Yang, J.T. Seo, S. Creekmore, D.A. Temple, P. Ye, M. Namkung, S.S. Jung, and J.H. Kim, "Influence of nonlinear phase mismatch on the atomic four-wave mixing in Bose-Einstein condensates," *Physical Review A*, 67, 13603 (2003).
4. J.T. Seo, Q. Yang, S. Creekmore, J. Mangana, J. Anderson, C. Pompey, D. Temple, X. Peng, J. Qu, W. Yu, A. Wang, A. Mott, M. Namkung, "Nonlinear Optical Spectroscopy of Cadmium Chalcogenide Nanocrystals," 2003 MRS Spring Meeting, April 21-25, San Francisco, CA. Document ID: 60553.
5. Ei Ei Nyein, U. Hömmerich, J. Heikenfeld, D.S. Lee, A.J. Steckl, J.M. Zavada, "Characterization of the red light emission from Eu doped GaN, Conference on Lasers and Electro-Optics (CLEO), 2003, Baltimore, MD.
6. Q. Yang, J.T. Seo, S.J. Creekmore, D. Temple, K.P. Yoo, S.Y. Kim, S. S. Jung, and A. Mott, "Distortions in Z-scan Spectroscopy," *Applied Physics Letters*, 82(1), 19 (2003).
7. Ei Ei Nyein, U. Hommerich, A. J. Steckl, J.M. Zavada, "Spectral and Time-resolved Photoluminescence Studies of Eu doped GaN", *Applied Physics Letters*, 82, (2003), 1655.
8. G. L. Tan, U. Hommerich, D. Temple, N. Q. Wu, J. G. Zheng, G. Loutts, "Synthesis and optical characterization of CdTe nanocrystals prepared by ball milling process", *Scripta Materialia* 48 (2003) 1469-1474.

Conference Talks

1. J.T. Seo, Q. Yang, S. Creekmore, J. Mangana, J. Anderson, C. Pompey, D. Temple, X. Peng, J. Qu, W. Yu, A. Wang, A. Mott, M. Namkung, "Nonlinear Optical Spectroscopy of Cadmium Chalcogenide Nanocrystals," 2003 MRS Spring Meeting, April 21-25, San Francisco, CA. Document ID: 60553.
2. U. Hömmerich, EiEi Nyein, D.S. Lee, J. Heikenfeld, A.J. Steckl, J.M. Zavada, "Photoluminescence studies of Rare-Earth (Er,Eu,Tm) doped GaN", European Materials Research Society (E_MRS) Meeting 2003, Strasbourg, France, 2003, invited talk.

3. J.Y. Lin, H. X. Jiang, P. Chow, U. Hömmerich, EiEi Nyein, H. Jenkinson, J.M. Zavada, "Synthesis and Optical Characterization of Erbium doped AlGaIn Quantum Wells", European Materials Research Society (E_MRS) Meeting 2003, Strasbourg, France, 2003.
4. Ei Ei Nyein, U. Hömmerich, J. Heikenfeld, D.S. Lee, A.J. Steckl, J.M. Zavada, "Characterization of the red light emission from Eu doped GaN, Conference on Lasers and Electro-Optics (CLEO), 2003, Baltimore, MD.
5. U. Hömmerich, EiEi Nyein, D.S. Lee, J. Heikenfeld, A.J. Steckl, J.M. Zavada, "Luminescence properties of rare earth doped GaN", invited talk, Workshop on Impurity based Electroluminescence in Wide-Gap Semiconductors", April 13-16, 2003, Santa Fe, NM.
6. Ei Ei Nyein, U. Hömmerich, D.S. Lee, J. Heikenfeld, A.J. Steckl, J.M. Zavada, "Spectroscopic studies on Er doped GaN as a function of Ga-flux, presented at the Workshop on Impurity based Electroluminescence in Wide-Gap Semiconductors", April 13-16, 2003, Santa Fe, NM.

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Refereed Publications and Conference Proceedings

1. A.A. Kaminskii, A.V. Butashin, A.F. Konstantinova, A.A. Pavlyuk, R.F. Klevtsova, F.A. Kuznetsov, A.A. Kornienko, E.A. Dunina, K. Ueda, J.B. Gruber, U. Hömmerich, J.T. Seo, D. Temple, B. Zandi, "Optical spectroscopy and visible stimulated emission of Dy^{3+} ions in monoclinic $KY(WO_4)_2$ and $KGd(WO_4)_2$ crystals," *Physical Review B*, **65**, 125108 (2002).
2. J.T. Seo, U. Hömmerich, A.J. Steckl, and J.M. Zavada, "Thermal quenching of photoluminescence from Er-doped GaN thin films," *Journal of Alloys and Compounds*, 341 (1-2), 62 (2002).
3. A.A. Kaminskii, A.V. Butashin, K.S. Aleksandrov, L.N. Bexmaternykh, V.L. Temerov, I.A. Gudim, N.V. Kravtsov, V.V. Firsov, J.T. Seo, U. Hommerich, D. Temple, and A. Braud, " $Gd_3Ga_5O_{12}:Nd^{3+}$ Crystals for a Continuous-Wave Diode-pumped Laser Operating in $^4F_{3/2} \rightarrow ^4I_{11/2}$ and $^4F_{3/2} \rightarrow ^4I_{13/2}$ Channels," *Journal of Crystallography Reports*, **47(2)**, 308 (2002).
4. A.G. Bluiett, U. Hommerich, R.T. Shah, S. B. Trivedi, S. W. Kutcher, C. C. Wang, "Observation of lasing from Cr^{2+} : CdTe and compositional effects in Cr^{2+} doped II-VI semiconductors", *Journal of Electronic Materials*, Vol. 31, No. 7, (2002), 806-810.
5. J. Zavada, U. Hommerich, and A. J. Steckl, "Excitation mechanisms of rare earth ions embedded in GaN thin films", *Electrochem. Soc. Meeting Proc. Vol. 2002-3*, May 2002.
6. S. B. Trivedi, F. Jin, S. W. Kutcher, C. C. Wang, G. V. Jagannathan, U. Hommerich, A. G. Bluiett, J.T. Seo, R. T. Shah, "Recent developments in II-VI compound based tunable solid-state laser materials and lasers", presented at the 1th International Workshop on the Physics of Semiconductor Devices (SPIE Vol. 4746), New Dehli, India.
7. Ei Ei Nyein, U. Hömmerich, J. Heikenfeld, D. S. Lee, A. J. Steckl, J. M. Zavada, "Spectroscopic evaluation of rare earth doped GaN for full color display applications", in *OSA Trends in Optics and Photonics (TOPS) Vol. 73, Conference on Lasers and Electro-Optics*, OSA Technical Digest, Postconference Edition (Optical Society of America, Washington, DC, 2002), p 654.
8. A. G. Bluiett, U. Hömmerich, R. T. Shah, S. B. Trivedi, S. W. Kutcher, and C. C. Wang, "Infrared Lasing from Cr^{2+} Doped CdTe and Optical Properties of Cr^{2+} Doped Ternary II-VI Hosts", in *OSA Trends in Optics and Photonics (TOPS) Vol. 73, Conference on Lasers and Electro-Optics*, OSA Technical Digest, Postconference Edition (Optical Society of America, Washington, DC, 2002), p 117-118.
9. Q. Yang, J.T. Seo, S. Creekmore, and D. Temple, "Nonlinear refraction and nonlinear absorption of CdTe microcrystals measured using ultrafast laser pulse," SPIE's 47th Annual Meeting, July 2002.

10. Q. Yang, J.T. Seo, S. Creekmore, and D. Temple, "I-scan measurements of the nonlinear refraction and nonlinear absorption coefficients of some nonlinear materials," SPIE's 47th Annual Meeting, July 2002.
11. A. G. Bluiett, R. T. Shah, and U. Hömmerich, S. B. Trivedi, S. W. Kutcher, and C. C. Wang, Crystal-Field Effects on the Optical Properties of Cr²⁺ ions in Cr Doped II-VI Semiconductors, American Physical Society March 2002 Meeting, Indianapolis, Indiana, March 18-22, 2002, oral presentation, paper G18-7.
12. Ei Ei Nyein, U. Hommerich, D. S. Lee, A. Steckl, J. M. Zavada, "Emission Properties of Er-doped GaN as a function of Ga flux, American Physical Society March 2002 Meeting, Indianapolis, Indiana, March 18-22, 2002, oral presentation, paper T18-6.
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Conference Talks

1. J.T. Seo, Q. Yang, S. Creekmore, D. Temple, M. Namkung, S.S. Jung, and J.H. Kim, "Evaluation of Nonlinear Optical Properties of Cadmium Chalcogenide Nanomaterials," International Conference on Superlattices Nano-Structures and Nano-devices, I-P032, July 22-26, 2002, Toulouse, France.
2. Q. Yang, J.T. Seo, S.J. Creekmore, D. Temple, K.P. Yoo, S.Y. Kim, and S.S. Jung, "Third-order nonlinearity of silica aerogel," OSA 2002 Annual Meeting, Orlando, FL, September 26 - October 03, 2002.
3. S. Creekmore, J.T. Seo, Q. Yang, D. Temple, M. Namkung, E.R. Generazio, S.S. Jung, and J.H. Kim, "Nonlinear Optical Susceptibility of II-VI Semiconductor Nanoscale Materials," The 11th International Symposium on the Physics of Semiconductors and Applications, August 20-23, 2002, Cheju Island, Korea.
4. J.T. Seo, S. Creekmore, Q. Wang, K.P. Yoo, S.Y. Kim, and S.S. Jung, "Nonlinear Optical Properties of Oxide Nanomaterials for Optical Power Limiting Application," International Conference on Solid States Crystals, Zakopane, Poland, October 2002, Invited Talk.
5. S. B. Trivedi, F. Jin, S. W. Kutcher, C. C. Wang, G. V. Jagannathan, U. Hommerich, A. G. Bluiett, J.T. Seo, R. T. Shah, "Recent developments in II-VI compound based tunable solid-state laser materials and lasers", presented at the 1th International Workshop on the Physics of Semiconductor Devices (SPIE Vol. 4746), New Dehli, India.
6. Q. Yang, J.T. Seo, S. Creekmore, and D. Temple, "Nonlinear refraction and nonlinear absorption of CdTe microcrystals measured using ultrafast laser pulse," SPIE's 47th Annual Meeting, July 2002.
7. Q. Yang, J.T. Seo, S. Creekmore, and D. Temple, "I-scan measurements of the nonlinear refraction and nonlinear absorption coefficients of some nonlinear materials," SPIE's 47th Annual Meeting, July 2002.
8. A. G. Bluiett, R. T. Shah, and U. Hömmerich, S. B. Trivedi, S. W. Kutcher, and C. C. Wang, Crystal-Field Effects on the Optical Properties of Cr²⁺ ions in Cr Doped II-VI Semiconductors,

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 10. J. Zavada, U. Hommerich, and A. J. Steckl, "Excitation mechanisms of rare earth ions embedded in GaN thin films", *Electrochem. Soc. Meeting Proc. Vol. 2002-3*, May 2002. Ei Ei Nyein, U. Hömmerich, J. Heikenfeld, D. S. Lee, A. J. Steckl, J. M. Zavada, "Spectroscopic evaluation of rare earth doped GaN for full color display applications", in *OSA Trends in Optics and Photonics (TOPS) Vol. 73, Conference on Lasers and Electro-Optics*, OSA Technical Digest, Postconference Edition (Optical Society of America, Washington, DC, 2002), p 654.
 11. A. G. Bluiett, U. Hömmerich, R. T. Shah, S. B. Trivedi, S. W. Kutcher, and C. C. Wang, "Infrared Lasing from Cr^{2+} Doped CdTe and Optical Properties of Cr^{2+} Doped Ternary II-VI Hosts", in *OSA Trends in Optics and Photonics (TOPS) Vol. 73, Conference on Lasers and Electro-Optics*, OSA Technical Digest, Postconference Edition (Optical Society of America, Washington, DC, 2002), p 117-118.

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Refereed Publications and Conference Proceedings

1. D.S. Lee, J. Heikenfeld, A.J. Steckl, U. Hommerich, J.T. Seo, A. Braud, and J. Zavada, "Optimum Er concentration for In-Situ doped GaN visible and IR luminescence," *Applied Physics Letters*, **79**(6), 719 (2001).
2. S.B. Trivedi, S.W. Kucher, C.C. Wang, G.V. Jagannathan, U. Hömmerich, A. Bluiett, M. Turner, J.T. Seo, K. Schepler, B. Schumm, P.R. Boyd, and G. Green, "Transition metal doped Cadmium manganese telluride: A new material for tunable mid-infrared lasing," *Journal of Electronic Materials* **30**(6), 728 (2001).
3. U. Hömmerich, J.T. Seo, C.R. Abernathy, A. J. Steckl, and J.M. Zavada, "Spectroscopic studies of the visible and infrared luminescence from Er doped GaN," *Materials Science Engineering B*, **81**, 116 (2001).
4. J.M. Zavada, C. J. Ellis, J.Y. Lin, H.X. Jiang, J.T. Seo, U. Hömmerich, M. Thaik, R.G. Wilson, P.A. Grudowski, and R.D. Dupuis, "Annealing behavior of luminescence from erbium-implanted GaN films," *Materials Science Engineering B*, **81**, 127 (2001).
5. Ei Ei Nyein, J. T. Seo, A. Bluiett, J. Anderson, U. Hommerich, J. Heikenfeld, M. Garter, D. S. Lee, A. J. Steckl, "Optical Spectroscopy of Europium doped Gallium Nitride prepared by Solid Source Molecular Beam Epitaxy", *Bull. Amer. Phys. Soc.*, Vol. 46, No.2 (2001), 106.
6. A. Bluiett, U. Hommerich, J.T. Seo, R. Shah, S. Trivedi, S. W. Kutcher, R. J. Chen, C. C. Wang, H. Zong, "Luminescence Dynamics of Cr^{2+} in CdTe and $\text{Cd}_{0.55}\text{Mn}_{0.45}\text{Te}$ ", *Bull. Amer. Phys. Soc.*, Vol. 46, No.2 (2001), 26.
7. C. C. Wang, S. Trivedi, F. Jin, J. B. Khurgin, D. Temple, U. Hömmerich, E. Gad, F. S. Choa, Y. S. Wu, A. Corder, "Interferometer-less Coherent Optical Range Finder", *Journal of Lightwave Technology*, Vol. 19, No. 5, (2001), 666-672.

Conference Talks

1. S.B. Trivedi, F. Jin, S. Kutcher, C.C. Wang, G.V. Jagannathan, U. Hömmerich, A.G. Bluiett, J.T. Seo, R.T. Shah, "Recent development in II-VI compound based tunable solid state laser materials and lasers," *Physics of Semiconductor Devices, XI International Workshop (IWPSD-2001)*, Indian Institute of Technology, Delhi, India, Dec. 11-15, 2001.

2. U. Hommerich, E. Nyein, J.T. Seo, A. Braud, D.S. Lee, A.J. Steckl, J.M. Zavada, "Photoluminescence Studies of Erbium and Europium doped Gallium Nitride Prepared by SSMBE," MRS Fall Meeting, 2001.
3. J. Zavada, U. Hommerich, J.T. Seo, A. Braud, E. Nyein, J. Heikenfeld, M. Garter, D.S. Lee, R. Birkhahn, and A. Steckl, "Thermal quenching characteristics of luminescence from RE ions in GaN thin films," Support of the 5th International Conference, Excited States of Transition Elements, Ladek Zdroj, Poland, June 6-11, 2001.
4. A. Bluiett, J.T. Seo, and U. Hommerich, "Recent results on the optical properties of Cr-doped II-VI semiconductors," Virginia Academy of Science, May 2001
5. E. Nyein, J.T. Seo, and U. Hommerich, "Evaluation of Eu-doped GaN for phosphor applications," Virginia Academy of Science, May 2001
6. J.T. Seo, U. Hommerich, A.J. Steckl, and J.M. Zavada, "Green and Near-Infrared Luminescence Properties of Er-doped GaN Grown by Solid-Source Molecular Beam Epitaxy," International Conference on Dynamical Processes in Excited States of Solids, Lyon, France (June, 2001).
7. J. T. Seo, U. Hommerich, A. Majchrowski, E. Michalski, and S. S. Jung, "Optical Spectroscopy and Stimulated Emission of Europium-doped Tungstates," International Conference on Dynamical Processes in Excited States of Solids, Lyon, France (June, 2001).
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9. D.S. Lee, J. Heikenfeld, M. Garter, A.J. Steckl, U. Hommerich, J.T. Seo, A. Braud, and J. Zavada, "Optimum Er concentration for In-Situ doped GaN visible and IR luminescence," 2001 Electronic Materials and Device Research Conference.
10. J.T. Seo, U. Hommerich, A.A. Kaminskii, A.A. Pavlyuk, "Optical Spectroscopy and Stimulated Emission of Dysprosium-doped Tungstates," April APS 2001.
11. E.E. Nyein, J.T. Seo, A. Bluiett, J. Anderson, U.H. Hommerich, J. Heikenfeld, M. Garter, D.S. Lee, A.J. Steckl, "Optical Spectroscopy of Europium doped Gallium Nitride prepared by Solid Source Molecular Beam Epitaxy," April APS 2001.
12. A. Bluiett, U. Hommerich, J.T. Seo, R. Shah, S.B. Trivedi, S.W. Kutcher, R.J. Chen, C.C. Wang, H. Zong, "Luminescence Dynamics of Cr^{2+} in CdTe and $\text{Cd}_{0.55}\text{Mn}_{0.45}\text{Te}$," April APS 2001.
13. A. A. Kaminskii, A. V. Butashin, S. N. Bagayev, N. Djeu, U. Hommerich, D. Temple, J. T. Seo, and A. A. Pavlyuk, "New Laser Potential of Dy^{3+} ions in insulating crystals", presented at the Third International Symposium of Modern Problems of Laser Physics, MPLP-2000, Akademgorodok, Novosibirsk, Russia, July 2- July 7, 2001.

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1. "Multiple Stokes and Anti-Stokes Generation in Triclinic \square - KIO_3 and Hexagonal \square - LiIO_3 Nonlinear Crystals," A. A. Kaminskii, H. J. Eichler, J. Hulliger, S. Haussuhl, T. H. Chyba, D. Temple, J. C. Barnes, V. N. Dolbinina, J. Findeisen, W. Jiyang, and L. Menkai, submitted to Laser Physics, 10 627-632, 2000.
2. "High Efficiency Nanosecond Raman Lasers Based on Tetragonal PbWO_4 Crystals," A. A. Kaminskii, C. L. McCray, H. R. Lee, S. W. Lee, D. A. Temple, T. H. Chyba, W. D. Marsh, J. C. Barnes, N. Annanenko, V. D. Legun, G. M. A. Gad, H. J. Eichler, and K. Ueda, Optics Commun. 183, 277-287, 2000.

3. Feng Jin, Jacob Khurgin, Chen-Chia Wang, Sudhir Trivedi, Yehuda Gabay, Esam Gad, Doyle Temple, Uwe Hömmerich, "Displacement measurement using transient photo-electromotive force effects in CdTe: V with frequency modulated lasers", *Applied Optics*, **39**, 3138-3142, (2000).
4. U. Hömmerich, J. T. Seo, J. M. Zavada, C. R. Abernathy, and A. J. Steckl, "Spectroscopic studies of the visible and infrared luminescence from Er doped GaN", *Materials Science and Engineering B*, in press.
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6. "Modeling and Observations of Phase-Mask Trapezoidal Profiles –with Grating-Fiber Image Reproduction", *Journal of Applied Optics*, Published Mar. 1, 2000, D. R. Lyons, J.V. Lindesay, H.R. Lee, Z. Ndlela, and **E.J. Thompson**.
7. "The Realization of a Bragg Reflection Filter Wavemeter", *Journal of Applied Optics*, Scheduled for Publication Nov. 1, 2000, **K. R. Samuel**, D. R. Lyons, and G-Y Yan.
8. J.M. Zavada, U. Hömmerich, and A. J. Steckl, "Light Emission from Rare Earth doped GaN", chapter for book entitled: III-V Nitride Semiconductors: Optical Properties, by H. Jiang and M. O. Manasreh, Gordon and Breach, in press.
9. U. Hömmerich, J. T. Seo, **Myo Thaik**, C. R. Abernathy, J. D. MacKenzie, J. M. Zavada, "Near infrared (1.54 μ m) luminescence properties of erbium doped gallium nitride", *Journal of Alloys and Compounds*, 303-304, 331-335 (2000).
10. J. T. Seo, U. Hömmerich, J. D. MacKenzie, C. R. Abernathy, J.M. Zavada, "Near-Infrared Luminescent Device and Optical Spectroscopy of Er-doped Gallium Nitride Prepared by Metalorganic Molecular Beam Epitaxy", *Journal of the Korean Physical Society*, **Vol. 36**, 311-315 (2000).
11. U. Hömmerich, J. T. Seo, J. D. MacKenzie, C. R. Abernathy, A. J. Steckl, R. Birkhahn, J.M. Zavada, "Comparison of the optical properties of erbium doped gallium nitride prepared by metalorganic molecular beam epitaxy (MOMBE) and solid source molecular beam epitaxy (SSMBE)", *MRS Internet J. Nitride Semicond. Res.* **5S1**, W11.65 (2000).
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15. **Charles A. Terrell**, Bagher M. Tabibi, Ja H. Lee, and **Darrell A. Spraggins**, "Non-Intrusive Optical Diagnostics Experiments for High-Speed Flow Generator Flowfield Characterization", *J. of Computer & Electrical Engineering* **26**, 67-76, (2000).
16. F. Jin, J. Khurgin, C.C. Wang, S. Trivedi, Y. Gabay, D. Temple, U. Hommerich, and E. Gad, "Applications of Photo-emf Effect in High Resolution and adjustable range displacement measurements", *Talk TuG6, Annual Meeting Optical Soc. of Am.*, October 22 - 26, 2000.
17. F. Jin, J. B. Khurgin, C. C. Wang, S. Trivedi, Y. Gabay, E. Gad, D. Temple, U. Hömmerich, "Displacement measurement with submicron resolution using photo-electromotive force effects and

- frequency-modulated lasers", in Conference on Lasers and Electro-Optics, OSA Technical Digest (Optical Society of America, Washington DC, 2000), pp. 102-103.
18. Wang F. Jin, J. B. Khurgin, S. Trivedi, D. Temple, U. Hömmerich, E. Gad, "Optical path length measurement using frequency-chirped laser pulses and an optical doppler frequency sensor", in Conference on Lasers and Electro-Optics, OSA Technical Digest (Optical Society of America, Washington DC, 2000), pp. 102-103.
 19. "Raman lasers based on lead tungstate crystals," A. A. Kaminskii, A. N. Annanenko and V. D. Legun, **C. L. McCray**, H. R. Lee, S. W. Lee and T. H. Chyba, W. D. Marsh, J. C. Barnes, and H. J. Eichler, Conference on Lasers and Electro-Optics, San Francisco, Ca., May 7-12, 2000, paper CThM13.
 20. "Tunable UV generation with a frequency-mixed Type II OPO," D. A. Richter, W. D. Marsh, N. S. Higdon, T. H. Chyba, and T. Zenker, IEEE Aerospace Laser Conference, Big Sky Montana, March 20-24, 2000, paper 240.
 21. "Multiple Stokes and Anti-Stokes Generation in Triclinic \square -KIO₃ and Hexagonal \square -LiIO₃ Crystals," A. A. Kaminskii, H. J. Eichler, J. Hulliger, S. Haussuhl, T. H. Chyba, D. Temple, J. C. Barnes, Conference on Lasers and Electro-Optics, San Francisco, Ca., May 7-12, 2000, paper CWV6.
 22. "Nanosecond Raman lasers based on lead tungstate crystals," A. A. Kaminskii, A. N. Annanenko, V. D. Legun, **C. L. McCray**, H. R. Lee, S. W. Lee, T. H. Chyba, W. D. Marsh, J. C. Barnes, H. J. Eichler, G. M. A. Gad and K. Ueda, Russian Laser Conference, Novosibirsk, Russia, July 3-7, 2000.
 23. "A Compact Ozone DIAL System," T. H. Chyba, T. Zenker, **R. Payne**, **C. Toppin**, B. Thomas, D. Harper, N. S. Higdon, D. A. Richter, and J. Fishman, 20th International Laser Radar Conference, Vichy, France, July 10-14, 2000.
 24. "The Center for Lidar and Atmospheric Sciences Students Scanning Aerosol Lidar," T. H. Chyba, D. A. Temple, S. Bailey, A. Bowman, A. Omar, B. Bradley, M. Edmondson, A. Futrell, C. Glenn, D. Harper, L. Haughton, S. Lee, K. Lewis, C. Meyer, R. Patterson, **R. Payne**, K. Reaves, L. Samuel, L. Williams, N. S. Higdon and D. A. Richter, 20th International Laser Radar Conference, Vichy, France, July 10-14, 2000.
 25. "Multiple Stokes and Anti-Stokes Generation in Triclinic \square -KIO₃ and Hexagonal \square -LiIO₃ Crystals," A. A. Kaminskii, H. J. Eichler, J. Hulliger, S. Haussuhl, T. H. Chyba, D. Temple, J. C. Barnes, Conference on Lasers and Electro-Optics, OSA Technical Digest (Optical Society of America, Washington DC, 2000), pp. 388-389.
 26. "Raman lasers based on lead tungstate crystals," A. A. Kaminskii, A. N. Annanenko and V. D. Legun, **C. L. McCray**, H. R. Lee, S. W. Lee and T. H. Chyba, W. D. Marsh, J. C. Barnes, and H. J. Eichler, Conference on Lasers and Electro-Optics, OSA Technical Digest (Optical Society of America, Washington DC, 2000), pg. 459.
 27. "Tunable UV generation with a frequency-mixed Type II OPO," D. A. Richter, W. D. Marsh, N. S. Higdon, T. H. Chyba, and T. Zenker, Proceedings of the IEEE Aerospace Laser Conference, CD-ROM (2000).
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 29. Chen-Chia Wang, Feng Jin, Jacob Khurgin, Sudhir Trivedi, Doyle Temple, Uwe Hommerich, Esam Gad, "Optical Path Length Measurements using Frequency-chirped Laser Pulses and an Optical

Doppler Frequency Sensor, Conference on Lasers and Electro-Optics (CLEO) 2000, May 7-12, San Francisco, CA, paper CFB4.

30. A. Mitofsky, G. C. Papen, S. G. Bishop, D. S. Lee, A. J. Steckl, J. T. Seo, U. Hömmerich, "Comparison of Er^{3+} Photoluminescence and Photoluminescence Excitation Spectroscopy in in-situ doped GaN: Er and Er-implanted GaN, accepted for presentation at the MRS Fall Meeting 2000.
31. J. M. Zavada, U. Hömmerich, J. T. Seo, A. J. Steckl, "Excitation wavelength dependent photoluminescence studies of Er doped GaN", accepted for presentation at the 4th International Conference on f-elements (ICFE'4), 17-21 September 2000, Madrid, Spain, paper C011.
32. U. Hömmerich, "Spectroscopic studies of the visible and infrared luminescence of Er doped GaN films", European Materials Research Society, Strasbourg, France, May 30-June 3 2000, paper 0690, invited talk.
33. J.M. Zavada, C. J. Ellis, J. Y. Lin, H. X. Jiang, J. T. Seo, U. Hommerich, M. Thaik, R. G. Wilson, "Annealing behavior of luminescence from Erbium implanted GaN films", European Materials Research Society, Strasbourg, France, May 30-June 3 2000, paper 0342.

Conference Talks

1. "Mathematical Modelling of an Aerosol Lidar System," L. Haughton, A. Futrell, D. A. Temple and T. H. Chyba, National Council of Undergraduate Research Annual Meeting, Missoula, Mt., April 28, 2000.
2. "The CLASS Project," D. A. Temple and T. H. Chyba, National Council of Undergraduate Research Annual Meeting, Missoula, Mt., April 28, 2000.
3. S. B. Trivedi, S. W. Kutcher, C. C. Wang, G. V. Jagannathan, U. Hömmerich, A. Bluiett, M. Turner, J. T. Seo, K. Schepler, B. Schumm, P. R. Boyd, G. Green, "Transition Metal doped Cadmium Manganese Telluride: A new material for tunable mid-infrared lasing", accepted for presentation at to the 2000 U. S. Workshop on the Physics and Chemistry of II-VI Materials, October 30-November 2, 2000, Albuquerque, NM.
4. J. T. Seo, U. Hömmerich, M. Turner, A. Bluiett, S. B. Trivedi, S. Kutcher, R. J. Chen, C. C. Wang, H. Zong, "Grating tuned Mid-Infrared laser of Chromium doped CdMnTe, presented at the Opto-Southeast SPIE meeting, 18-19 Sept. 2000, Charlotte, NC, SES03-11.
5. U. Hömmerich, J. T. Seo, R. Birkhahn, A. J. Steckl, J. M. Zavada, "Spectroscopic Evaluation of erbium doped Gallium Nitride for Optoelectronic Applications", presented at the Opto-Southeast SPIE meeting, 18-19 Sept. 2000, Charlotte, NC, paper SE03-08.
6. A. Bluiett, U. Hömmerich, J. T. Seo, M. Turner, S. B. Trivedi, S. W. Kucher, R. J. Chen, C. C. Wang, The ternary matrix $\text{Cd}_{1-x}\text{Mn}_x\text{Te}$ as a host for Cr^{2+} and Co^{2+} ions for mid-infrared laser development", presented at the Opto-Southeast SPIE meeting, 18-19 Sept. 2000, Charlotte, NC, paper SE03-12.
7. A. Bluiett, U. Hömmerich, J. T. Seo, S. B. Trivedi, S. W. Kutcher, R. J. Chen, C. C. Wang, H. Zong, "Laser Spectroscopy of Co^{2+} and Cr^{2+} doped Cadmium Chalcogenides" 178th Annual Meeting of Virginia Academy of Science, May 24-26, 2000, Radford, VA, Materials Science Section, paper 10-40.
8. M. Turner, U. Hömmerich, J. T. Seo, A. Bluiett, S. B. Trivedi, S. W. Kutcher, R. J. Chen, C. C. Wang, H. Zong, "Optical and Laser Properties of a mid-infrared gain medium: Cr^{2+} doped $\text{Cd}_{0.55}\text{Mn}_{0.45}\text{Te}$ ", 178th Annual Meeting of Virginia Academy of Science, May 24-26, 2000, Radford, VA, Materials Science Section, paper 2-40.
9. J. T. Seo, U. Hömmerich, A. Bluiett, M. Turner, D. Temple, S. B. Trivedi, S. B. Trivedi, S. W. Kutcher, R. J. Chen, C. C. Wang, H. Zong, "Crystal Growth, Optical Spectroscopy, and Tunable

- Mid-Infrared lasing of Chromium doped Cadmium Manganese Telluride”, 2000 March Meeting of the American Physical Society, March 20-24, Minneapolis, MN, paper V9-9.
10. J. T. Seo, U. Hommerich, R. Birkhahn, A. J. Steckl, J. M. Zavada, “Optical Spectroscopy of Erbium doped Gallium Nitride prepared by Solid-Source Molecular Beam Epitaxy”, 2000 March Meeting of the American Physical Society, March 20-24, Minneapolis, MN, paper V17-11.
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 35. F. Jin, J. B. Khurgin, C. C. Wang, S. Trivedi, Y. Gabay, E. Gad, D. Temple, U. Hömmerich, “Displacement measurement with submicron resolution using photo-electromotive force effects and frequency-modulated lasers”, in Conference on Lasers and Electro-Optics, OSA Technical Digest (Optical Society of America, Washington DC, 2000), pp. 102-103.
 36. Wang F. Jin, J. B. Khurgin, S. Trivedi, D. Temple, U. Hömmerich, E. Gad, “Optical path length measurement using frequency-chirped laser pulses and an optical doppler frequency sensor”, in Conference on Lasers and Electro-Optics, OSA Technical Digest (Optical Society of America, Washington DC, 2000), pp. 102-103.
 37. “Raman lasers based on lead tungstate crystals,” A. A. Kaminskii, A. N. Annanenkov and V. D. Legun, **C. L. McCray**, H. R. Lee, S. W. Lee and T. H. Chyba, W. D. Marsh, J. C. Barnes, and H. J. Eichler, Conference on Lasers and Electro-Optics, San Francisco, Ca., May 7-12, 2000, paper CThM13.
 38. “Tunable UV generation with a frequency-mixed Type II OPO,” D. A. Richter, W. D. Marsh, N. S. Higdon, T. H. Chyba, and T. Zenker, IEEE Aerospace Laser Conference, Big Sky Montana, March 20-24, 2000, paper 240.
 39. “Multiple Stokes and Anti-Stokes Generation in Triclinic \square -KIO₃ and Hexagonal \square -LiIO₃ Crystals,” A. A. Kaminskii, H. J. Eichler, J. Hulliger, S. Haussuhl, T. H. Chyba, D. Temple, J. C. Barnes, Conference on Lasers and Electro-Optics, San Francisco, Ca., May 7-12, 2000, paper CWV6.
 40. “Nanosecond Raman lasers based on lead tungstate crystals,” A. A. Kaminskii, A. N. Annanenkov, V. D. Legun, **C. L. McCray**, H. R. Lee, S. W. Lee, T. H. Chyba, W. D. Marsh, J. C. Barnes, H. J. Eichler, G. M. A. Gad and K. Ueda, Russian Laser Conference, Novosibirsk, Russia, July 3-7, 2000.
 41. “A Compact Ozone DIAL System,” T. H. Chyba, T. Zenker, **R. Payne**, **C. Toppin**, B. Thomas, D. Harper, N. S. Higdon, D. A. Richter, and J. Fishman, 20th International Laser Radar Conference, Vichy, France, July 10-14, 2000.
 42. “The Center for Lidar and Atmospheric Sciences Students Scanning Aerosol Lidar,” T. H. Chyba, D. A. Temple, S. Bailey, A. Bowman, A. Omar, B. Bradley, M. Edmondson, A. Futrell, C. Glenn, D. Harper, L. Haughton, S. Lee, K. Lewis, C. Meyer, R. Patterson, **R. Payne**, K. Reaves, L. Samuel, L. Williams, N. S. Higdon and D. A. Richter, 20th International Laser Radar Conference, Vichy, France, July 10-14, 2000.
 43. “Multiple Stokes and Anti-Stokes Generation in Triclinic \square -KIO₃ and Hexagonal \square -LiIO₃ Crystals,” A. A. Kaminskii, H. J. Eichler, J. Hulliger, S. Haussuhl, T. H. Chyba, D. Temple, J. C. Barnes, Conference on Lasers and Electro-Optics, OSA Technical Digest (Optical Society of America, Washington DC, 2000), pp. 388-389.
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47. Chen-Chia Wang, Feng Jin, Jacob Khurgin, Sudhir Trivedi, Doyle Temple, Uwe Hommerich, Esam Gad, "Optical Path Length Measurements using Frequency-chirped Laser Pulses and an Optical Doppler Frequency Sensor, Conference on Lasers and Electro-Optics (CLEO) 2000, May 7-12, San Francisco, CA, paper CFB4.
48. A. Mitofsky, G. C. Papen, S. G. Bishop, D. S. Lee, A. J. Steckl, J. T. Seo, U. Hömmerich, "Comparison of Er^{3+} Photoluminescence and Photoluminescence Excitation Spectroscopy in in-situ doped GaN: Er and Er-implanted GaN, accepted for presentation at the MRS Fall Meeting 2000.
49. J. M. Zavada, U. Hömmerich, J. T. Seo, A. J. Steckl, "Excitation wavelength dependent photoluminescence studies of Er doped GaN", accepted for presentation at the 4th International Conference on f-elements (ICFE'4), 17-21 September 2000, Madrid, Spain, paper Co11.
50. U. Hömmerich, "Spectroscopic studies of the visible and infrared luminescence of Er doped GaN films", European Materials Research Society, Strasbourg, France, May 30-June 3 2000, paper 0690, invited talk.
51. J.M. Zavada, C. J. Ellis, J. Y. Lin, H. X. Jiang, J. T. Seo, U. Hommerich, M. Thaik, R. G. Wilson, "Annealing behavior of luminescence from Erbium implanted GaN films", European Materials Research Society, Strasbourg, France, May 30-June 3 2000, paper 0342.

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Refereed Publications and Conference Proceedings

1. "High Resolution Spectral Measurements of Raman Shifts in Barium Nitrate," C. L. McCray and T. H. Chyba, *Optical Materials*, **11**, 383-390, 1999.
2. **Bluiett**, U. Hömmerich, J. T. Seo, S. B. Trivedi, S. B. Trivedi, S. W. Kutcher, R. J. Chen, C. C. Wang, H. Zong, A. Kaminskii, U. Hömmerich, D. Temple, J. T. Seo, A.A. Pavlyuk, New Laser Potential of Monoclinic $\text{KR}(\text{WO}_4)_2\text{:Ln}^{3+}$ Tungstates (R=Y and Ln), *Phys. Stat. Sol (a)*, **174**, R7 (1999).
3. U. Hömmerich, J. T. Seo, **Myo Thaik**, J. D. MacKenzie, C. R. Abernathy, S. J. Pearton, R. G. Wilson, J. M. Zavada, "Optical characterization of erbium doped III-nitrides prepared by metalorganic molecular beam epitaxy", *Internet J. Nitride Semicond. Res.* **4S1**, G11.6 (1999).
4. J. M. Zavada, H. P. Shen, **Myo Thaik**, U. Hömmerich, J. D. MacKenzie, C. R. Abernathy, F. Ren H. Xiang, J. Lin, "Luminescence from erbium-doped gallium nitride thin films", *Internet J. Nitride Semicond. Res.* **4S1**, G11.1 (1999).
5. J. T. Seo, U. Hömmerich, S. B. Trivedi, R. J. Chen, S. Kutcher, C. C. Wang, H. Zong, Phillip R. Boyd, and Wayne Tardiff, "Spectroscopy and Tunable Mid-Infrared Lasing of a Novel Gain-Medium: Cr^{2+} -doped $\text{Cd}_{0.85}\text{Mn}_{0.15}\text{Te}$ ", *Journal of the Korean Physical Society*, Vol. 34, No.3, 221-226 (1999).
6. "A compact, ground-based uv DIAL system for measurements of tropospheric ozone", T. Zenker, T. H. Chyba, C. L. McCray, H. R. Lee, **B. Thomas**, **R. Elivert**, **C. Toppin**, **D. Larson**, N. S. Higdon, D. A. Richter, and J. Fishman in *Laser Radar Technology and Applications IV*, Gary W. Kamerman, Christian Werner, Eds., Proceedings of SPIE Vol. 3707, 541-548 (1999).

7. "An OPO-based lidar system for DIAL measurements of methane and mid-IR trace gases", **S. W. Lee, J. McNeil**, T. Zenker, T. H. Chyba in Laser Radar Technology and Applications IV, Gary W. Kamerman, Christian Werner, Eds., Proceedings of SPIE Vol. 3707, 549-555 (1999).
8. "A mid-IR OPO-based lidar system for DIAL measurements of tropospheric methane concentrations", **S. W. Lee, J. McNeil**, T. Zenker, and T. H. Chyba, Conference on Lasers and Electro-optics OSA Technical Digest (Optical Society of America, Washington DC, 1999) pg. 425.
9. "A compact uv ozone DIAL system", T. H. Chyba, T. Zenker, **C. L. McCray**, H. R. Lee, **R. Elivert, B. Thomas, C. Toppin, and D. Larson**, N. S. Higdon, and D. A. Richter, and J. Fishman in *Optical Remote Sensing of the Atmosphere*, OSA Technical Digest (Optical Society of America, Washington, DC, 1999), pp. 38-40.
10. "Measurements of tropospheric ozone with a compact uv DIAL system", T. H. Chyba, T. Zenker, **C. L. McCray**, H. R. Lee, **R. Elivert, B. Thomas, C. Toppin, and D. Larson**, N. S. Higdon, and D. A. Richter, and J. Fishman in Application of Lidar to Current Atmospheric Topics III, Proceedings of SPIE Vol. 3757, 80-86 (1999).
11. "Concentration Measurements of Methane Sources with an OPO-Based Differential Absorption Lidar System" **S. W. Lee, J. McNeil**, T. Zenker, and T. H. Chyba in Application of Lidar to Current Atmospheric Topics III, Proceedings of SPIE Vol. 3757, 96-102 (1999).
12. "Birefringence compensation in a barium nitrate Raman laser," H. R. Lee, **C. L. McCray**, and T. H. Chyba, Conference on Lasers and Electro-Optics/Pacific Rim '99 Technical Digest, 638-639 (1999).
13. "Methane Concentration Measurements with a Mid-Infrared Optical Parametric Oscillator-Based Differential Absorption Lidar System", **Sang W. Lee, J. McNeil**, T. Zenker, and T. H. Chyba, Conference on Lasers and Electro-Optics/Pacific Rim, '99 Technical Digest, 272-273 (1999).
14. "Status of the development of a Low-cost differential absorption lidar system for tropospheric ozone studies", T. H. Chyba, T. Zenker, N. S. Higdon, D. A. Richter, and J. Fishman, Sixth Scientific Conference of the International Global Atmospheric Chemistry Project (IGAC), September 13-17, Bologna, Italy, poster paper
15. "Tests of a compact lidar for global monitoring of tropospheric ozone", T. H. Chyba, T. Zenker, **R. Payne, C. Toppin, M. Edmondson, K. Lewis**, D. Harper, N. S. Higdon, and D. A. Richter, and J. Fishman, in Environmental Monitoring and Remediation Technologies II, Proceedings of the SPIE, Vol. 3853, 94-100 (1999).
16. U. Hömmerich, J. T. Seo, **M. Turner, A. Bluiett**, S. B. Trivedi, H. Zong, S. W. Kutcher, C. C. Wang, R. J. Chen, "Mid-infrared laser development based on transition metal doped Cadmium Manganese Telluride", accepted for presentation at the International Conference on Luminescence and Optical Spectroscopy of Condensed Matter, Osaka, Japan, Aug. 23-27, 1999.
17. U. Hömmerich, J. T. Seo, **Myo Thaik**, C. R. Abernathy, J. D. MacKenzie, J. M. Zavada, "Er-doped III-Nitride semiconductors, novel materials for optoelectronic applications", accepted for presentation at the International Conference on Luminescence and Optical Spectroscopy of Condensed Matter, Osaka, Japan, Aug. 23-27, 1999.
18. U. Hömmerich, J. T. Seo, Myo Thaik, C. R. Abernathy, J. D. MacKenzie, J. M. Zavada, "Near infrared (1.54 μm) Luminescence Properties of erbium doped gallium nitride", 22nd Rare Earth Research Conference, Argonne National Lab., July 10-15, 1999, paper PI.30.
19. J. M. Zavada, **M. Thaik**, U. Hömmerich, J. D. MacKenzie, C. R. Abernathy, S. J. Pearton, R. G. Wilson, "Luminescence characteristics of Er-doped GaN semiconductor thin films", presented at the 3rd International Winter Workshop on Spectroscopy and Structure of Rare Earth Systems, Szklarska Poreba, Poland, April 27-May 1, 1999.
20. U. Hömmerich, **M. Turner, A. Bluiett**, J. T. Seo, H. Zong, S. B. Trivedi, S. W. Kutcher, C. C. Wang, R. J. Chen, B. R. Boyd, W. Tardiff, "Mid-infrared luminescence properties of Cr^{2+} and Co^{2+}

- doped CdTe and Cadmium Manganese Telluride", Conference on Lasers and Electro-Optics (CLEO'99), Baltimore, MD, May 17-21, 1999, paper CTHK37.
21. **Myo Thaik**, J. T. Seo, U. Hömmerich, C. R. Abernathy, S. J. Pearton, J. D. MacKenzie, R.G. Wilson, J. M. Zavada, "Near IR and Visible Photoluminescence from Er doped III-Nitride Semiconductors", Conference on Lasers and Electro-Optics (CLEO'99), Baltimore, MD, May 17-21, 1999, paper CThK38.
 22. **George Ofori-Boadu**, **Kirk M. Peterson**, **Joshua Mangana**, U. Hömmerich, "Colorimetric determination of trace pollutants in water using photothermal deflection spectroscopy", Conference on Quantum Electronics (QELS'99), Baltimore, MD, May 17-21, 1999, paper QWD19.
 23. U. Hömmerich, J. T. Seo, J. D. MacKenzie, C. R. Abernathy, A. J. Steckl, R. Birkhahn, J.M. Zavada, "Comparison of the optical properties of erbium doped gallium nitride prepared by metalorganic molecular beam epitaxy (MOMBE) and solid source molecular beam epitaxy (SSMBE)", MRS Fall 99 Meeting.
 24. U. Hömmerich, J. T. Seo, **A. Bluiett**, **M. Turner**, L. Salary, D. Temple, S. B. Trivedi, S. W. Kutcher, R. J. Chen, C. C. Wang, H. Zong, "Growth, spectroscopy, and mid-infrared laser performance of chromium doped Cadmium Manganese Telluride", MRS Fall 99 Meeting.

Conference Talks

1. J. T. Seo, U. Hömmerich, and J. Zavada, "Optical Properties of Erbium doped III-Nitride Semiconductors", SES99 Meeting of the American Physical Society.
2. **A. Bluiett**, U. Hömmerich, J. T. Seo, S. B. Trivedi, "Spectroscopic studies of the laser crystals for vibronic mid-infrared lasers", SES99 Meeting of the American Physical Society.
3. **M. Turner**, J.T. Seo, U. Hömmerich, S. B. Trivedi, "Optical and Laser Studies of Cr^{2+} : $\text{Cd}_{0.55}\text{Mn}_{0.45}\text{Te}$ ", SES99 Meeting of the American Physical Society.
4. **George Ofori-Boadu**, **Kirk Peterson**, and U. Hömmerich, "Photothermal spectroscopy applied to environmental monitoring", SES99 Meeting of the American Physical Society.

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3. "Measurements of stimulated Raman amplification and oscillation in barium nitrate," **C. L. McCray** and T. H. Chyba, in Advanced Solid State Lasers, Technical Digest (Optical Society of America, Washington, D.C., 1998), pp. 139-141.
4. "Measurements of stimulated Raman amplification and Raman shifts in barium nitrate", **C. L. McCray**, **S. W. Lee**, and T. H. Chyba, OSA Trends in Optics and Photonics Vol. 19, Advanced Solid State Lasers, W. Bosenberg and M. M. Fejer, eds. (Optical Society of America, Washington, DC 1998), pp. 550-554.
5. A compact ground-based differential absorption lidar for measurements of tropospheric ozone", T. H. Chyba, T. Zenker, **C. L. McCray**, H. R. Lee, **B. Thomas**, **R. Elivert**, N. S. Higdon, D. A. Richter, and J. Fishman 1998 OSA Annual Meeting, October 4-9, 1998, paper WDD22.
6. "High intracavity uv power generation from a cw laser", **R. T. David**, T. H. Chyba, C. E. Keppel, **D. Gaskell**, and R. Ent 1998 OSA Annual Meeting, October 4-9, 1998, paper WDD24.

7. "Development of an OPO-based mid-infrared lidar system for atmospheric measurements of methane", S. W. Lee, T. Zenker, and T. H. Chyba, 1998 OSA Annual Meeting, October 4-9, 1998, paper WDD6.
8. "Characterization of water vapor lines in the 940-nm region," C. K. Williamson, T. H. Chyba, and E. V. Browell, Federation of Analytical Chemistry and Spectroscopy Societies, Austin, Tx., October 11-16, 1998, paper 681.
9. S. J. Pearton, C. R. Abernathy, J. D. MacKenzie, U. Hömmerich, R. G. Wilson, R. N. Schwartz, and J. M. Zavada, "Hydrogen Passivation of Er doped AlN, Materials Research Society (MRS) Proceedings, Vol. 483, 1998.
10. U. Hömmerich, **Myo Thaik**, T. Robinson-Brown, J. D. MacKenzie, C. R. Abernathy, S. J. Pearton, R.G. Wilson and R. N. Schwartz, J.M. Zavada, "High Temperature Photoluminescence and Photoluminescence Excitation Spectroscopy of Erbium doped Gallium Nitride", MRS Proceedings, Vol. 483, 1998, 685.
11. U. Hömmerich, **Myo Thaik**, **George Ofori-Boadu**, **Jakeithia Prejean**, J. T. Seo, J. D. MacKenzie, C. R. Abernathy, S. J. Pearton, R.G. Wilson, J.M. Zavada and O. Ambacher, "Optical Characterization of Erbium doped III-Nitrides prepared by metalorganic molecular beam epitaxy", MRS Fall Meeting, Boston, 1998.
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13. **M. Turner**, J. T. Seo, U. Hommerich, S. B. Trivedi, R. J. Chen, and S. Kutcher, "Optical Properties and Mid-Infrared Laser Behavior of Chromium doped $\text{Cd}_{0.55}\text{Mn}_{0.45}\text{Te}$ ", OSA Annual Meeting 1998, Baltimore, MD, October 4-9, 1998.
14. J. T. Seo, U. Hömmerich, S. B. Trivedi, R. J. Chen, S. Kutcher, K. Grasza, "Efficient tunable mid-infrared lasing from Cr: $\text{Cd}_{0.85}\text{Mn}_{0.15}\text{Te}$, Conference on Lasers and Electro-Optics (CLEO 98), San Francisco, CA, Mai 3-8 1998, paper CTuC3.
15. J. D. MacKenzie, C. R. Abernathy, S. J. Pearton, U. Hömmerich, F. Ren, J.M. Zavada, "Growth and Luminescence Properties of III-N:Er doped during chemical beam epitaxy", Material Research Society, Spring Meeting 1998, San Francisco, CA, April 13-17, 1998, paper D14.5.

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1. U. Hömmerich, **Myo Thaik**, R. N. Schwartz, R. G. Wilson, J. M. Zavada S. J. Pearton, C. R. Abernathy, J. D. MacKenzie, "Evaluation of erbium doped III-nitride semiconductors for photonic applications", 193rd Electrochemical Society Meeting 98, San Diego, CA, May 3-8.
2. J.M. Zavada, **Myo Thaik**, U. Hömmerich, J. D. MacKenzie, C. R. Abernathy, "Infrared LEDs based on Er doping of III-V nitride semiconductors, 193rd Electrochemical Society Meeting 98, San Diego, CA, May 3-8.
3. **Matthew Turner** and Uwe Hömmerich, "Evaluation of Manganese doped $\text{Ca}_5(\text{PO}_4)_3\text{F}$ as a near infrared (1-2 μm) solid-state laser material", in NASA University Research Centers Technical Advances on Education, Aeronautics, Space, Autonomy, Earth, and Environment, Vol.2, Proceedings of the NASA URC Technical Conference 1997, ACE Center Press, Albuquerque, (1997), pp.875-879.
4. **Myo Thaik**, U. Hömmerich, R. N. Schwartz, R. G. Wilson, J. .M. Zavada, "1.54 μm Emission from Erbium implanted GaN for Photonic Applications", in NASA University Research Centers Technical Advances on Education, Aeronautics, Space, Autonomy, Earth, and Environment, Vol.2, Proceedings of the NASA URC Technical Conference 1997, ACE Center Press, Huntsville, Alabama (1998), pp.875-879.

5. "Development of a compact ground-based ozone DIAL system", T. H. Chyba, T. Zenker, **C. L. McCray**, H. R. Lee, **B. Thomas**, **R. Elivert**, N. S. Higdon, D. A. Richter, and J. Fishman, in Proceedings of the 19th International Laser Radar Conference, ed. by U.N. Singh, S. Ismail, and G. K. Schwemmer, (NASA Langley Research Center, Hampton, Va.), pp. 779-782, 1998.
6. "An OPO-based lidar system for differential absorption measurements of methane in the 3 micron region", **S. W. Lee**, T. Zenker, and T. H. Chyba, in Proceedings of the 19th International Laser Radar Conference, ed. by U.N. Singh, S. Ismail, and G. K. Schwemmer, (NASA Langley Research Center, Hampton, Va., 1998), pp. 853-856.
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8. J. D. Mackenzie, C. R. Abernathy, S. J. Pearton, U. Hommerich, J. M. Zavada, "III-N: Er Materials doped during growth by chemical beam epitaxy, presented at the 40th Electronic Materials Conference (TMS), Charlottesville, VA, June 24-26, 1998

1997 Statistics

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1. Qingnan Wang, **Apriel Hodari** and Doyle Temple, "Edge Effects in Photorefractive Thin Films," J. Appl. Phys. **81**,1-5 (1997)
2. Q. Wang and D. A. Temple, "The Effect of Substrates on Photorefractive Thin Films in the Transverse Geometry," Poster CTuP4, Conference on Lasers and Electro-Optics, Baltimore, Maryland, May 18-23 (1997)
3. Q. Wang and D. A. Temple, "The Effect Of Substrates On the Transverse Geometry Photorefractive Thin Films," Accepted to the journal of Applied Physics October 15, 1997
4. "Solid state barium nitrate Raman laser in the visible region", C. He and T. H. Chyba, Opt. Comm. **135**, 273-278 (1997).
5. "Advanced airborne water vapor DIAL development and measurements", T. H. Chyba, P. Ponsardin, N. S. Higdon, R. J. De Young, Butler, C. F., and E. V. Browell, in Proceedings of the 18th International Laser Radar Conference, (Springer-Verlag, Berlin, 1997) pp. 301-304.
6. "Development of an all-solid state Raman laser for ozone DIAL measurements", **C. L. McCray** and T. H. Chyba, in Optical Remote Sensing of the Atmosphere, Vol. 5, 1997 OSA Technical Digest Series (Optical Society of America, Washington, DC, 1997), pp. 171-173.
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9. J. M. Zavada, **M. Thaik**, U. Hömmerich J. D. MacKenzie, and C. R. Abernathy, "Optical Absorption in Er-doped III-V Nitride Semiconductor Films, Optical Society of America Meeting 1997.
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12. J. M. MacKenzie, C. R. Abernathy, S. J. Pearton, U. Hömmerich, X. Wu, F. Ren, R. G. Wilson, J. Zavada, "Er incorporation and optical activity in group III-N materials grown by Metalorganic Molecular Beam Epitaxy, presented at MRS Spring Meeting, San Francisco, CA, March 31-April 4, 1997.
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1. **McCray, Christophe**, and T. H. Chyba, "Barium nitrate Raman laser development for the remote sensing of ozone", NASA University Research Center Technical Conference, 1997, Albuquerque, New Mexico, February 18, 1997, paper TUP5-03.
2. Gaskell, D., T.P. Welch, K. Assamagan, T. Chyba, **R. David**, C. E. Keppel, G. Savage, C. Cuevas, R. Ent, V. Lebedev, J. Mitchell, C. Sinclair, M. Poelker, B. W. Vulcan, B. E. Norum, K.B. Wang, "Development of a Laser Cavity for Compton Polarimetry and as a High-Energy Polarized Photon Source", American Physical Society 1997 Meeting, Washington, D.C., April 18-21, 1997, paper F8 2.
3. "Development of a Laser Cavity for Compton Polarimetry and as a High-Energy Polarized Photon Source", **D. Gaskell**, T. P. Welch, K. Assamagan, T. Chyba, **R. David**, C. E. Keppel, G. Savage, C. Cuevas, R. Ent, V. Lebedev, J. Mitchell, C. Sinclair, M. Poelker, B. W. Vulcan, B. E. Norum, K.B. Wang, American Physical Society 1997 Meeting, Washington, D.C., April 18-21, 1997, paper F8 2.
4. **V.R. Davis**, X. Wu, U. Hömmerich, S. B. Trivedi, K. Grasza, and Z. Yu, "Optical Characterization and 2,525 μm Lasing of Cr²⁺: Cd_{0.85}Mn_{0.15}Te", in NASA University Research Centers Technical Advances on Education, Aeronautics, Space, Autonomy, Earth, and Environment, Vol.1, Proceedings of the NASA URC Technical Conference 1997, ACE Center Press, Albuquerque, (1997), pp.875-879.
5. "Non-Intrusive Optical Diagnostic Methods for flowfield Characterization", Bagher M. Tabibi et al, "NASA University Research Centers, Vol. 1, pp 711-716 (1997).

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2. Q. Wang and D. Temple, "Surface Charge Layer Effect In Photorefractive Thin Films," Opt. Soc. Am. Annual Meeting, Rochester (1996)
3. Q.N. Wang and D. A. Temple, "Transport in photorefractive thin films," Poster CWF3 Conference on Lasers and Electro-Optics (CLEO), Anaheim, CA, June 2-7, 1996.
4. U. Hömmerich, F. Namavar, A. Cremins, and **K. L. Bray**, "A spectroscopic study on the luminescence of Er in porous Si", Appl. Phys. Lett. **68**, 1951, (1996).
5. "Solid State Barium Nitrate Raman Laser in the Visible Region", C. He and T. H. Chyba, CLEO/QELS 1996 Annual Meeting, May, 1996 postdeadline paper.
6. "Thermal Lensing Measurements in Barium Nitrate", **C. L. McCray**, C. He, and T. H. Chyba , Optical Society of America 1996 Annual Meeting, paper MYY4.
7. All Solid-State UV Laser Sources Based on Barium Nitrate Raman Scattering for Ozone DIAL System", T. H. Chyba and C. He, Optical Society of America 1996 Annual Meeting, paper MYY3.
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1. Calvin W. Lowe, and S.C.Mathur; PERIODIC DIELECTRIC STRUCTURES: Theme lecture delivered at IX National Seminar on Ferroelectrics and Dielectrics held at National Physical Laboratory, New Delhi, India, from October 8 - 11, 1996.
2. Calvin W. Lowe, and S.C.Mathur, PHOTONIC BANDGAP CRYSTALS: INVITED TALK delivered at 3rd Intensive tutorial and International conference on semiconductor materials and devices held at Delhi University and National Physical Laboratory, New Delhi, India from December 16 -21, 1996 .
3. **Kang I. Seo**, Satish C. Mathur, and Calvin W. Lowe, Growth Mechanism and Optical Properties of a New Nitroaromatic Compound, 17th congress of the International Commission for Optics (Taejon, Korea), Aug. 19-23, 1996.
4. **Kang I. Seo** and Calvin W. Lowe, Optical Waveguide Based on Organic Mixed MNA-MAP Evaporated Thin Films, Polymeric and Organic Materials for Optical Applications (Orlando, FL), Aug 25-30, 1996.
5. Y. Choi, **D.X. Nguyen**, B.M. Tabibi, and J.H. Lee, "Installation and Preliminary Operation of a Solar Thermal-Electric Propulsion System," Paper 96-2321, presented at the 27th AIAA Plasmadynamics and Lasers Conference, June 17-20, 1996, New Orleans.
6. Choi, **D.X. Nguyen**, B.M. Tabibi, and J.H. Lee, "Installation and Preliminary Operation of a Solar Thermal and Electric Propulsion System", AIAA 27th Plasmadynamics and Lasers Conference, June 17-20, 1996, New Orleans, LA, Conf. proceeding, paper AIAA 96-2321.
7. **Charles A. Terrell**, Bagher M. Tabibi, and Ja H. Lee, "Electron Beam Fluorescence of N_2^{++} Quenching Rate", Bulletin of the APS, Program of the 1996 Fall Meeting of the SESAP Society, Vol. 41, No. 8, November 1996. Abstract AC 2
8. **Darrell A. Spraggins**, Bagher M. Tabibi, Ja H. Lee, and Leonard M. Weinstein, "A Small-Field, High-Sensitivity Focusing Schlieren System for Flowfield Visualization", Bulletin of the APS, Program of the 1996 Fall Meeting of the SESAP Society, Vol. 41, No. 8, November 1996. Abstract AC 9.

9. **Dung X. Nguyen, Cecily J. Smith**, Bagher M. Tabibi, and Ja H. Lee, "Preliminary Operation of a Solar Thermal-Electric Propulsion (STEP) System", Bulletin of the APS, Program of the 1996 Fall Meeting of the SESAP Society, Vol. 41, No. 8, November 1996. Abstract AB 5.
10. C.J. Pittman and D. A. Temple, "Outreach Programs in Physics at Hampton University," Proceedings of the SPIE 1996 Symposium on Optical Science, Engineering and Instrumentation, Talk 2809-30, Denver, Colorado, August 4-9 (1996)

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2. **F. Etap**, K. I. Seo and C. T. Lee, Binomial Mixed State Reflected from a Grey Well, Quantum Semiclass. Opt. 7, 1-7, 1995.
3. G. Harvey, T. H. Chyba, and M. Cimolino, "Cleanliness and damage measurements of optics in atmospheric sensing high energy lasers" Proceedings of the Annual Symposium on Optical Materials for High Power Lasers, PROC SPIE 2714, 696 - 706, 1995.
4. U. Hömmerich, X. Wu, F. Namavar, A. Cremins, and **K. L. Bray**, "Photoluminescence properties of Er doped porous silicon", presented at the Material Research Society 1995 Fall Meeting, Boston, MA.

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1. G. Harvey, T. H. Chyba, and M. Cimolino, "Cleanliness and damage measurements of optics in atmospheric sensing high energy lasers" presented at the Annual Symposium on Optical Materials for High Power Lasers, Boulder, Colorado, October 30, 1995.
2. **Kang I. Seo**, Growth Mechanism for Aromatic Organic thin Films, 14th Annual Meeting Alabama Images and Microscopy (Birmingham, AL), March 23-24, 1995.
3. **Kang I. Seo**, Isaac Jones, and Calvin W. Lowe, Growth and Characterization of Vacuum Deposited Organic Thin Films, Organic thin Films for Photonic Applications (Portland, OR) ACS 1995 Tech. Digest Series 21 p85, Sept. 11-14, 1995.
4. Q. N. Wang and D. A. Temple, "Photorefractive Transport in Transverse Geometry Thin Films," Talk MH1, International Conference on Lasers 95, Charleston, SC, Dec. 4 - 8, 1995
5. T. M. Thaik, Y.S. Choi, **C.A. Terrell**, B.M. Tabibi, and J.H. Lee, "Thermal-Electric Propulsion with Magnetoplasmdynamic Acceleration", Presented at 62nd Annual Meeting of SESAPS, Tallahassee, FL, Nov. 1995, Bulletin of the APS, Vol. 40, No.13, DC 7.
6. **D. Nguyen**, **M. Thaik**, Y.S. Choi, **C.A. Terrell**, B.M. Tabibi, and J.H. Lee, "Thermal-Electric Propulsion with Magnetoplasmdynamic Acceleration", Presented at 62nd Annual Meeting of SESAPS, Tallahassee, FL, Nov. 1995, Bulletin of the APS, Vol. 40, No.13, DC 7.
7. H. Choi, Ja H. Lee, and Bagher M. Tabibi, "Solar Thermal-Electric Propulsion System for Orbital Transfer Performance", 31st AIAA/ASME/SAE/ ASEE, Joint Propulsion Conference and Exhibit, July 10-12, 1995/San Diego, CA, Paper AIAA 95-2574.
8. G. Harvey and T. H. Chyba, "Ultra Cleaning and Certification of High Performance Optics", NASA Langley Technologies Opportunities Showcase-TOPS '95, NASA Langley, Hampton, Va, April 6-8, 1995.

1994 Statistics

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1. B.M. Tabibi, C. A. Terrell, "CW Iodine Laser Performance of t-C4F9I Under Closely-Simulated Air-Mass-Zero Solar Pumping", Optics Communications, 109, 1994, 86-92.

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1. Bagher M. Tabibi, Sang H. Choi, and Ja. H. Lee, "Thermal-Electric Propulsion with magnetoplasmadynamic Acceleration", 25th AIAA Plasmadynamics and Lasers Conference, June 20-22, 1994/Colorado Springs, Co., Paper AIAA 94-2468.
2. **Charles A. Terrell**, Dr. Bagher M. Tabibi, et al, "Effect of Argon on N2+ First Negative Emission and Modal Temperatures", Presented at 61st Annual Meeting of SESAPS (Nov., 1994).
3. I.H. Hwang, "Second Harmonic Generation of Diode Pumped Nd:YAG with KTP Crystal," 72nd Annual Meeting of the Virginia Academy of Science, James Madison University, Harrisburg, VA May 19-20, 1994

1993 Statistics

Refereed Publications and Conference Proceedings

1. **Charles A. Terrell**, Dr. Bagher M. Tabibi, et al, "CW Iodine Laser Performance of t-C4F9I Under Closely-Simulated AM0 Solar-Pumping", Poster presented at CLEO,1993 (May, 1993).
2. Usamah Farrukh and Norman Barnes, "Time-dependent temperature in laser block crystals: impact of selective cooling", TuU8, Optical Society of America's Annual Meeting, October 3-8, 1993.
3. Zhou, **A. K. Hodari**, I. H. Hwang and D. D. Venable, "An end-pumped Cr:Nd:GSGG laser," Virginia Journal of Science 44, 109 (May 1993).
4. Usamah Farrukh and Philip Brockman, "Temperature Distribution in end-pumped Crystal Laser Rods: Transient and Spatial Variation," Applied Optics, Vol 32, No. 12, pp. 2075-2082 (1993).

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1. **Charles A. Terrell**, Dr. Bagher M. Tabibi, et al, "CW Iodine Laser Performance of t-C4F9I Under Closely-Simulated AM0 Solar Pumping", Honorable Mention Presentation at the 71st Annual Meeting of the Virginia Academy of Science (May, 1993).
2. Farrukh and N. Barnes, "Time-dependent temperature profiles in end-pumped laser rods: non circular pump cross section", TuU7, Optical Society of America's Annual Meeting, October 3-8, 1993.
3. **Charles A. Terrell**, Dr. Bagher M. Tabibi, et al, "CW Iodine Laser Performance of t-C4F9I Under Closely-Simulated AM0 Solar-Pumping", Conference on Lasers and Electro-Optics CLEO,1993.

1992 Statistics

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2. B. Tabibi, J. H. Heinbockel, R. C. Costent, and J. H. Lee,"A 30-W CW Solar Simulator-Pumped Iodine Laser", CLEO'92 Conference, Anaheim, CA., May 10-15 (1992), Paper CWG8.

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1. **Charles A. Terrell**, Dr. Bagher M. Tabibi, et al, "CW Iodine Laser Performance of t-C4F9I Under Closely-Simulated AM0 Solar Pumping", Presented at 59th Annual Meeting of SESAPS (Nov., 1992).
2. **C. Terrell**, B. M. Tabibi, et al, "CW Iodine Laser Performance of t-C4F9I Under Closely-Simulated AM0 Solar Pumping", Presented at 59th Annual Meeting of SESAPS (Nov. 1992).

APPENDIX C: External Funding

Investigators	Agency	Total Amount	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
K. Han	ONR	\$81,276	\$81,276										
K. Han	NASA	\$109,733	\$54,866	\$54,865									
B. Tabibi	AOSR	\$431,650		\$215,825	\$215,825								
B. Tabibi	AOSR	\$25,000		\$12,500	\$12,500								
B. Tabibi	AOSR	\$632,204			\$164,412	\$168,440	\$155,710	\$143,743					
B. Tabibi	NASA	\$78,263				\$78,263							
B. Tabibi	NASA	\$12,000				\$12,000							
G. Simms	NSF	\$312,069			\$70,017	\$70,017	\$70,017	\$70,017					
U. Farrukh	ARL	\$30,000		\$30,000									
D. Lyons	NASA	\$275,000				\$68,750	\$68,750	\$68,750	\$68,750				
D. Lyons	NASA	\$475,000						\$60,000	\$118,750	\$118,750	\$118,750		
D. Temple and W. Buck	NSF	\$180,000							\$60,000	\$60,000			
D. Temple and C. Rankin	NSF	\$180,000							\$62,330	\$62,330	\$60,000	\$60,000	\$60,000
D. Temple, T. Chyba & J. Russell	NASA	\$187,000							\$500,000	\$500,000	\$500,000	\$500,000	\$500,000
D. Temple & T. Chyba	NASA	\$2,500,000				\$42,159	\$40,934						
T. Chyba	NASA	\$83,093				\$61,000	\$82,000	\$109,500	\$22,625				
T. Chyba	NASA	\$247,000						\$90,000	\$180,000	\$90,000			
T. Chyba	NASA	\$360,000								\$50,000	\$100,000	\$50,000	
T. Chyba	NASA	\$200,000								\$95,000	\$90,000		
T. Chyba	AOSR	\$185,000								\$8,000			
T. Chyba	VSGC	\$8,000											
T. Chyba	VSGC	\$8,000											
T. Chyba	Textron	\$10,000									\$8,000		
T. Chyba	LaRC	\$24,000									\$10,000		
U. Hommerich	ARO	\$175,000					\$57,000	\$58,000	\$55,000		\$24,000		
U. Hommerich	ARO	\$155,000											
U. Hommerich	ARO	\$182,000							\$155,000				
U. Hommerich	NSF	\$350,000								\$60,000	\$60,000	\$62,000	
U. Hommerich	AOSR	\$185,000							\$90,000	\$100,000	\$75,000		
J. Seo	ARO	\$180,000										\$925,000	\$925,000
J. Seo	ARL	\$185,000										\$90,000	\$90,000
												\$90,000	\$95,000

